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Vol. 2
Technical Notes

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Canadian Outdoor Recreation Demand Study

Vol. 2: Technical Notes

Parks Canada
Staff and Consultants

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An Ontario Research Council on Leisure Publication

ACKNOWLEDGEMENTS

Many people have contributed to the preparation of this volume. Jay Beaman was responsible for both the content and the format of the primary text. Considerable assistance was provided by the various members of the CORD Study Technical Committee, other provincial researchers, and Parks Canada personnel.

It will be obvious to readers of this volume that "putting it altogether" was a very complicated process. Original material was typed, and then edited for style and readability by John Nash, Robert Farrell, Barbara Doyle, Lynne Belfry, and Barry Roberts. Gordon Ewing and Stephen Smith both, at times, served as technical editors. Edited material was then "typed" on to magnetic cards, and the card images were transfered to magnetic tape. John Buck and Lacey Lavigne deserve special mention for conducting special computer processing in Ottawa, while Steven Breen and many staff members of the University of Waterloo Computing Centre were instrumental in processing the volume's content for final editing and printing in Waterloo. Printing plates were made from mylar printed computer "output" and original material, by personnel in the Graphic Services Department of the University. Stanley Valant coordinated operations in Ottawa during the final stages of the process.

Appreciation is due to the publishers of Technical Notes that originally appeared in a number of professional publications (see Appendix B). Special efforts were made by each of the authors of all Technical Notes in preparing revised versions of their work for this publication. Many have rewritten large sections of their articles and contributed additional graphic materials for illustrative purposes. Stephen Smith painstakingly examined each of the equations in this volume and edited them with respect to the narrative content and the apparent intent of each of the authors. This latter aspect of the editing process became necessary primarily because of the idiosyncrasies of the computer software and hardware used to produce this text. However, primary responsibility for this final version of the volume rests with myself and Terry Stewart, and other members of the staff of the Leisure Studies Data Bank of the Waterloo Research Institute.

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FOREWORD

Parks Canada is pleased to make this material available to the research community. The contents of this volume are truly as the subtitle suggests - technical. Whereas Volume I in this series is intended primarily for administrative and policy personnel, this volume is intended primarily for researchers. The contents include a wealth of new and exciting approaches to the study of outdoor recreation and recreation research in general.

In 1967, when Knetsch produced an exploratory CORD Study research program, the state of recreation research was embryonic. At that time no one could have predicted which available methodological techniques essential to the CORD Study needed to be revised and which new techniques would need to be developed. Work on park-use survey methods was released in 1968. The only discussions of motivation factors affecting participation rates that were being produced at that time were theoretical rather than practical. Needless to say each of us is aware of the rapid development of computer useage and methodolgy that has had a revolutionary effect upon large-scale data processing and analysis since 1967. Demand estimation methodologies were published in 1969. All this occurred while CORD Study researchers were in the field collecting data.

As this volume indicates, new analysis techniques had to be developed throughout the Study. Some of these techniques are still undergoing testing and refinement. In many ways, Canada has assumed a leadership role in this effort. As late as 1974, the United States Bureau of Outdoor Recreation still perceived the field of outdoor recreation to be in such a state that it held a National Seminar to define recreation research needs.

Considering all of the factors cited, it would have been easy to have abandoned the CORD Study in the face of developments which suggested possibly better ways to achieve the aims of the Study. However, by taking a flexible view of the original design, and solving methodological problems as they arose, the Study has produced much that can be considered a major contribution to research methodology. This volume then, in the years to come, will provide researchers and others with a text that can serve as a methodological reference and as an instructional source.

John I. Nicol,
Director General,
Parks Canada.

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A KEY TO READING THE EQUATIONS IN THE TEXT

Because of the limitations imposed by the computer print train used to produce this text, certain substitutions of standard printed mathematical notations were necessary. The following is a guide to these:

TEXT NOTATION	STANDARD NOTATION
@E	Σ (summation)
PROD	Π (product of several terms)
PI	π (3.1416...)
x**y	X^y (x raised to the power of y)
x**(1/2)	$\sqrt{x}$ (square root of x)
expY	e^y (e raised to the power of y)
ε	$\in$ (error term)
d[x]	∂x (differential)
ɫ	$\int$ (integration)
Ƚ	λ (lambda)
X²	χ^2 (chi-squared)
approx =	$\cong$ (approximately equal to)

Some symbols, e.g. - "EL" have been used in place of certain arbitary notations (e.g. - λ). The meaning of these symbols have been explained in the text. In most instances, when modifications to an equation were necessary because of the length of a printed line or spacing of text, FORTRAN notation was used.

CHAPTER I

INTRODUCTION TO THE CANADIAN OUTDOOR RECREATION DEMAND STUDY TECHNICAL NOTES

GENERALITIES

The Canadian Outdoor Recreation Demand (CORD) Study Technical Notes are a tangible product of the CORD Study. Following the acceptance of the design by J.L. Knetsch (see DESIGN FOR ASSESSING OUTDOOR RECREATION DEMAND IN CANADA below), which contained plans for data collection, it was necessary to specify the analyses needed. Technical Note (TN) 34, the "Working Paper", was prepared as a first step in meeting the need for specific analysis strategies. In TN 34, Knetsch stated:

> If demand relationships can be understood with even a modicum of success, various kinds of productive analyses are possible that provide at least partial answers to many difficult problems. This is not to suggest, as was pointed out in the original design paper, that demand analyses can provide clear-cut answers to planning problems. They cannot. Rather, it is to suggest that demand analyses can provide important information useful for planning and policy decisions.

An integral aspect of research must be to anticipate policy and planning needs; however, it is necessary to remember that every Canadian Parks organization has its own particular policies and priorities. No one research effort can concentrate on all needs of all organizations; rather, all organizations involved in recreation research will have only certain basic concerns in common. While policies and objectives may vary, there will be large areas in which important exchanges can take place. These can include exchanges of quantitative information, of conceptual development, and of research findings related to methods and ways of evaluating policy. It is within the context of such exchange that a CORD Study type of cooperative effort has the greatest promise of success.

The CORD Study could never provide specific answers to questions about how much outdoor recreation land should be acquired in Canada, and where. The "why" behind this is very simply that the "shoulds" in relation to need for recreation land can be defined only when comprehensive recreation policies are specified. Land policy, manpower or program needs, should only be specified in a plan when details of budgetary priorities and the issues of trade-offs between having parks and historic sites rather than hospitals and

schools (or at least the trade-offs between competing recreation activities) have been worked out. Part of negotiating such trade-offs, (as indicated in the "Working Paper"), from an economist's perspective should include learning what value is put on park or historic site use, in comparison to other consumption.

In 1976 (as in 1967), when one starts to consider using "research" to aid policy makers and planners, one finds a rather "shabby" collection of tools. Even though the CORD Study made major progress in many areas, more methodological development remains to be done. Often, what staff researchers and consultants do for organizations using accepted methods is methodologically unsound, and unbiased "intuition" might offer better results (and cost much less).

In preparing this volume CORD Study researchers have had to confront two sets of circumstances, 1) a set of circumstances suggesting the necessity of a volume such as this, and 2) situations that have pointed out the fallacy of, and problems with conclusions that show how much hunting, fishing, driving for pleasure, tent camping, etc., there will or should be in the future. Although many researchers and consultants estimate "demand", and conduct "sophisticated modelling", such work is scratching the surface of a very complex problem. Generally, in a conceptual, structural, and statistical sense, good models and methods have not been defined. For example debate on the use of consumer surplus to measure park value was at its peak in the mid-sixties. Critiques of work in these areas were needed to give researchers guidance so they could know which work by others should be used and which should not. CORD Study Technical Notes to a large extent are intended to offer researchers this type of critique.

TN 34, the Working Paper, is presented to indicate how the CORD Study analysis developed along lines laid down in 1969. It provides a framework in which to illustrate how certain Technical Notes relate to the efforts made to understand the demand for outdoor recreation. It also indicates the rationale for dividing this volume into various collections of Technical Notes.

Given the methodological thrust of the CORD Study and given that the "Working Paper" specified certain research areas and related methodological problems, the Technical Notes came to be classified under a number of specific headings. The classification scheme used in this volume is only one possible classification scheme for organizing the Notes (see Table 2). Part of the problem in classifying the Notes arises because a single Note can be placed under several headings. The non-mutually exclusive classification of some of the Notes given in Table 2 illustrates this problem. Thus the inclusion of an article in a particular chapter is somewhat arbitrary.

Introductory material to the Notes in each chapter gives the reader some information about the events leading to the preparation of specific Technical Notes and provides other background that the technical editor believes the

reader will find interesting and useful.

The reviews at the ends of each chapter differ substantially from each other in terms of 1) their thrust or objective and 2) individual author's style. The reviews do not point out detailed relationships between Notes in one chapter and Notes in a later chapter, nor do they make extensive, detailed or subtle reference to Notes in earlier chapters. The approach taken was to make each review primarily a review of the Notes in one chapter. Discussion of relationships and implications between different Notes is found in Chapters X and XI. However, numerous cross-referencing does take place.

Table 1 indicates in numerical order, short titles for the forty-two CORD Study Technical Notes. This table is provided to facilitate quick reference to the Technical Notes cited only by number in most references.

There has been no attempt to make the volume self-contained by providing lengthy explanations or descriptions of other research. This volume is intended for recreation research personnel who keep up with the demand analysis literature. Nevertheless, some of the references are obscure, and to prevent problems in locating such material, Parks Canada has made copies available of all listed references which are not in journals or otherwise readily available. These documents are on file in the LEISURE STUDIES DATA BANK, of The Waterloo Research Institute; and copies can be obtained at cost.

Finally, this volume does not provide general information on the Canadian Outdoor Recreation Demand Study, nor are there details on collection or processing of CORD Study data. Persons interested in generalities about the CORD Study may refer to Volume I: OVERVIEW AND ASSESSMENT. Those who wish to have more details on CORD Study data collection and processing, or who wish to replicate analyses or carry out new analyses, may see Volume III: DATA COLLECTION AND DOCUMENTATION. References to both of these volumes in this work are given using abbreviated titles.

TABLE 1

TECHNICAL NOTES - SHORT TITLES

1. Day-Use Model
2. Attractivity Indices
3. Alternative-Site Measures
4. Attractiveness, Emissiveness and Travel
5. Potentials and Needs
6. Origin Models Accuracy Estimates
7. Site Comparison Model
8. Loading Curves
9. Comparing Attractiveness Measures
10. Deriving Activity Packages
11. Generalized Visitor Flow Model
12. Participation and ANOVA
13. Statistical Projections
14. Distance Functions and Travel
15. Application of ANOVA
16. Calculating Supply
17. Allocating Supply
18. Enroute Overnight-Use Model
19. Use Estimates and Structural Adequacy
20. ANOVA With Interaction Effects
21. Monitoring Use
22. Participation Trends
23. LP Land Allocation
24. Data Comparability
25. Cost-Effectiveness Analysis
26. Participation Measures
27. River Quality Perception
28. Comparing Attractiveness Measures
29. Participation Data and Supply Measurements
30. Prediction Methods and Overnight Use
31. Consumer Surplus and Park Value
32. Cluster Analysis Applications
33. CORD Study Unity
34. Demand Assessment Outline
35. Gravity Models
36. Origin Models and Values of R^2
37. Substitutability Concept Comments
38. Consumer Surplus Benefit Estimates
39. Estimating Park Economic Impact
40. Park Impact: Case Study
41. Campground Development Implicators
42. Geographic Data Processing Applications

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TABLE 2

TECHNICAL NOTES CLASSIFICATION SCHEME

Topic	Technical Note Number
Destination Modelling	1, 4, 7, 8, 11, 14, 18, 19, 30, 31, 32, 34, 35, 38
Park Attractivity	1, 2, 4, 9, 27, 28
Alternative Factors	1, 3, 9, 11, 33
Origin Modelling	6, 12, 13, 20, 29, 33, 34, 36
Use Trends/Future Use	7, 12, 13, 20, 22

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A DESIGN FOR ASSESSING OUTDOOR RECREATION DEMANDS IN CANADA (1967)

J.L. Knetsch

This report presents the design of a series of investigations to assess the demand for outdoor recreation in Canada. The purpose is to set out the major conclusions of this design effort, and to focus attention on the more critical points on which decisions will need to be made in the near future. The intent is to discuss only major inferences and concerns, and to point out those to which the earliest attention should be given. Extended discussion of the many methodological points and findings reached in the course of the design study can better be brought out in other communications and reports. See especially the CORD Study Data Collection and Documentation Volumes.

There are six major areas of conclusions:

1. A critical need exists to have a far more complete understanding and measurement of outdoor recreation demands in Canada, to guide investment and management planning, to identify and evaluate policy choices, and to forecast recreation use of resources in Canada as it relates to alternative development proposals.

2. Demand studies are fully feasible at the current time within reasonable cost limits. Results of the contemplated studies would be directly applicable to outdoor recreation program planning at the several levels of responsibility in Canada. Demand studies do not directly supply policy and planning solutions, but they do provide an important basis for making better decisions.

3. The necessary investigations should be done as a series of complementing tasks which combine into a strategy of studies rather than as a single, more limiting study of outdoor recreation demand. None by itself is a demand study, but the whole series will provide needed demand estimates.

4. The major components of the overall study would center first on tasks primarily to acquire data from:
    a. household surveys,
    b. park user surveys,
    c. supply inventories.

   The study would then utilize the results of these surveys

in a series of analytical steps to assess demands and needs, and to formulate planning and policy implications. The result of the entire effort is heavily dependent on the data program. Work on each of the three data programs should be initiated early to supply the necessary information in sequence and to provide a more comprehensive data base. There is a need for compatibility and uniformity in outdoor recreation data necessary for the demand study - which is collected by the different agencies and jurisdictions. While a focus may be on the National Parks, data and exchanges of data from other sources, especially the Provinces, are necessary to assess the demand for a wider spectrum of outdoor recreation and to appraise meaningfully the demand for use of the federal areas. Further, as the use of each recreation area, regardless of jurisdictional responsibility, bears relation to the use of others in a region, data associated with a full range of recreation opportunities will need to be obtained.

5. The several studies which are to be undertaken should be done in part by responsible agencies and organizations outside of Parks Canada and in part by staff members of the Department. The capabilities of the different groups differ widely, as do the requirements for individual tasks in the demand studies. Responsibility for coordination of the studies should best remain within Parks Canada.

6. The studies should be structured to provide for a continuing process of demand assessment. Demand responds to alterations in the population and to changes in the facilities and opportunities provided to that population. Therefore, there can be no "once and for all" determination of "the outdoor recreation demand." To provide the useful guide to planning and policy for which it is designed, the assessments will need to be continuing. The major cost of the demand studies will be in the early stages with continuing programs of demand studies becoming far more routine, and subsequently, less expensive.

OUTDOOR RECREATION AND DEMAND

A result of the accelerating effect of technological, economic, political, and social changes in our society and in our environment has been a rapidly increasing awareness of environmental amenities, their destruction, their lack of availability, and increases in the demands for them. This is especially true, and seems to find the sharpest focus in, the case of parks and outdoor recreation. It has been amply demonstrated that the demand for outdoor recreation is large and is growing. If the physical opportunities exist - and that is important - many people choose to spend time and

money on outdoor recreation. This is reflected in all series of statistics or indices of magnitude – attendance counts, license fees collected, equipment sales, or recreation travel.

It is not enough to know that demand is increasing. Public bodies – at national, provincial, and local levels – and private firms need to have the nature of demand for activities and facilities defined in such a way that they can make rational policy and investment decisions to meet the expressed desires of the various user publics.

The chief need is a better definition and examination of the demand for recreation activities and facilities that vary by type, location, and management. Information is required on the future demand for present facilities and for alternative areas and facilities that might be added.

Demand studies have a very practical purpose. Their objective is to yield estimates or forecasts for improving or adjusting the supply of recreation opportunities and to estimate the probable effects of alternative programs and policies. Recreation planners at any jurisdictional level remain at a loss without some notion of how recreation use will respond to alternative recreation opportunities that might be provided.

What is needed is not a collection of miscellaneous facts, but an understanding of the relationships inherent in recreation behavior and ability to forecast the effects of proposed alternative actions. A more efficient and equitable provision of recreation opportunities is dependent upon the recognition of the wide spectrum of outdoor recreation possibilities in all regions of the country, and an assessment of the relative demands for different segments of this spectrum. Demand statements are tangible expressions of personal values that are most significant as guides to what people actually want.

Park and recreation area attendance statistics are collected by nearly all public park and recreation agencies. While there are difficulties associated with the accuracy and comparability of these figures, the major weakness is that far more data and analysis are required before an explanation can be offered for the patterns of use that occur. If the statistics from different areas are to be meaningful, and if much is to be learned from them, they must be related to economic, social, and physical environments.

Many past studies of recreation demand have yielded far less than would have been possible with similar resources. A major factor has been a misunderstanding of the quantitative results. This in large part stems from confusion of recreation demand terminology, given wide currency by the U.S. Outdoor Recreation Resource Review Commission studies. Many have unfortunately and uncritically read into this early work, and subsequently propagated, erroneous concepts of demand. The trouble arises from a confusion over the difference between demand and consumption. Use or attendance figures are incorrectly called demand, instead of being

interpreted as consumption or the interaction of both demand, which certainly exists, and supply of opportunities, which also exists. The amount of recreation demand varies with the number of facilities available, thereby making some quantitative estimate of this dependence necessary for sensible planning.

This is more than semantics. It can direct planning efforts to wrong conclusions or to irrelevancies and blunt plans and investment policy in outdoor recreation. As Professor Wantrup warned years ago:

> "existing projections of land and water use are neither conceptually nor empirically identical with projections of land and water demand. In the first place, use projections do not separate demand/supply conceptually nor statistically. If demand is to serve as a principal orientation for public land and water policy - that is to help in planning on the supply side - problems of demand and supply need to be separated conceptually and in empirical investigation, variables pertaining to demand must be differentiated from those pertaining to supply."

The warning has been repeated in the technical literature, and empirical evidence supports the importance of distinguishing between consumption and demand. Consumption data refer to and are measures of participation. Participation is dependent upon demand but it is also dependent upon supply. In fact, participation rates seem more likely to vary with the supply of opportunities than with demand factors. For example, people make greater use of water recreation facilities per capita in the Maritimes than they do in the Prairies, the differences having far more to do with the availability of water than with differences in incomes, education, or age distribution between the two populations. The point is that observation of what occurs will not alone permit judgments of relative demands.

The extent to which the standardized methods and an improper notion and interpretation of demand can go astray was illustrated by public discussion of the Wisconsin Council of Ontario's Conference on Parks and Outdoor Recreation in April of 1967. The evaluation of the user statistics as demand followed the prevalent "demand" determination methods. This led to the conclusion that some $93,000,000 was needed in further recreation facilities to catch up with demand. If these added facilities were put in place and the same study repeated, it would unfortunately show that instead of having met the demand with the expenditure, as would have been expected, the gap between supply and demand would be even greater! The added facility supply would have brought about increased visitor numbers which would then be mistakenly read as even greater "demand".

A methodology which mistakes consumption, or in the case of recreation, visits or use with demand, will indicate more demand for the same type of facilities in those areas where more of the facilities are located. This can have the important consequence of perpetuating the kind of facilities already in place in the areas already best served. Thus, as facilities are developed and used, new studies would report that more of the same should be built in these places. Nearly any manner or amount of investment can be "justified" and investment decisions may be severely warped. Furthermore, some of the most important recreation demands of the population are never brought to light. It says, in effect, that if only white bread is available for purchases, the subsequent buying of white bread by people shows that there exists a demand for white bread but none for brown and only more white bread should be supplied.

The standardization of methodology, the bulk of the reports, the mass of machine-derived numbers, and the dollar cost involved do not lessen the inherent weakness of these procedures. The concepts underlining the methods are simply inadequate for the intended purpose, making the subsequent collection of facts and figures almost worthless.

The single most serious and most fundamental deficiency in most demand surveys and studies is that they do not provide any means of determining how recreation use will respond to changes in supply - and that, after all, is the portion on which guidance is needed. The studies, consequently, are of little value as an aid to planning or to policy decisions.

Recreation demand studies, to be useful for planning purposes, must consider the effect of both supply and demand factors on recreation use or participation. Use data in the form of participation rates of population segments or visits to recreation areas must be obtained, but the interpretation must consider that both demand and supply variables explain or determine these rates. That is, the emphasis should be placed on determining and explaining patterns of use which emerge given an availability of opportunities and the characteristics of the using populations. Data should be collected and analyzed in such a way that predictions can be made of how the use patterns would be expected to change given changes in supply, that is, changes in the availability of recreation opportunity. This would allow estimates to be made of the consequences of varying recreation investments or varying recreation policies. For example, it would then be possible to make a forecast of the use that might be expected of a proposed provincial recreation area, taking explicitly into account such things as its location, size, facilities, and the existence of other recreation areas in proximity to it.

The important implication of this for the design of recreation demand investigations is that it is quite impossible to carry out studies in a meaningful way by only asking people how many times they participated in various kinds of outdoor recreation activities. The supply of

opportunities is ignored; consequently, very little of the difference in participation rates among different individuals or even groups of individuals can be explained. A far more critical part of the explanation of recreation behavior is the supply side of the equation.

Statements can be made of the demand in Canada for any commodity - automobiles, houses, or beef - but these must be taken to mean the quantity demanded at the prevailing prices, incomes and given levels of other factors. If these prices or other factors were different, the amount demanded would differ. The demand for outdoor recreation similarly depends on various factors. One of the most important of these is the availability of opportunities, there can be no set quantity of recreation demanded by a population. Any prediction of recreation demand must, therefore, consider supply elements.

Listings of recreation areas, with their characteristics and other inventory data, are compiled in increasingly complete fashion. However, owing to lack of standardization in facility measurement, the difficulty of assessing general resource availability for activities such as hunting and fishing which take place outside organized recreation areas, and the complexity of coping with quality differences, measures of supply are not easily quantified. Whatever explicit measures of supply are available must be made an integral part of any studies to be undertaken.

The demand study should be designed to yield data for making estimates and gaining insights into the recreation demand phenomena throughout Canada for a very broad spectrum of outdoor activities. The spectrum of outdoor recreation should be as wide as possible. Remote recreation opportunities such as many of the National Parks, various types of intermediate areas such as many Provincial Parks, and user-oriented recreation areas typified by urban parks, should all be included. Studies should point out the demands for outdoor recreation in Canada, the roles played both by the National Parks and by other park and recreation areas in meeting this demand. In setting forth a broad view of recreation as a point of departure, insight can be gained into the varied demands for recreation and the interrelationships between these demands.

The data should be collected and analyzed in such a way that estimates of the complementarities and competitive aspects between recreation areas and facilities can be estimated, however crudely. It should be possible to say, for example, that if the facilities or opportunities are increased in an area by a certain amount, that the visitation to existing areas should go up, down, or remain unchanged. This would have very important implications for investment decisions and policy formulation. For instance, it would be of great interest to know the effect of development of Provincial parks and recreation areas on the use which is made of National Parks and - probably even more important and of greater magnitude - the effect of development of urban-oriented outdoor recreation areas on

Provincial parks.

Another aspect which the demand studies must consider is the pent-up demands not now currently being expressed by the population because of the non-availability of facilities or areas. The appraisal of this aspect of demand can prove most difficult. It is one thing to estimate how use would vary depending upon the proximity of population to a park or recreation area of a given type and quality, but it is quite another problem to estimate the use which would take place in an area or at a facility which does not currently exist. Some estimate or feeling beyond sheer conjecture of such demands is needed. The demands can perhaps be approximated by observing close parallels and extrapolating from this experience, or they may be partially assessed through household surveys.

Another general problem which is also difficult is to establish demand parameters in such a way that useful statements can be made about changes in demands over time, particularly over the long periods of time which are implicitly contemplated in recreation investments. Recreation in its current dimension is a rather recent phenomenon, certainly in large part stemming from the post World War II period. As such, the relationships have not been as stable as relationships existing for many commodities in which demand studies are often made, such as food products, apparel, automobiles, or appliances. There are within outdoor recreation activities degrees of faddism and rapid changes in taste, sometimes owing to changes in technology as, for example, in motor boating. That the general demand for outdoor recreation will be increasing throughout the foreseeable future is undeniable, but estimating the changes in the components of the demand is going to pose continuing difficulty. The study should be designed to yield some insight into these problems.

The study should also proceed so that further investigations can be carried on which will complement the initial or early studies. That is, the recreation demand study cannot be a "once and for all" study but should be a continuing program of research and planning with a series of new studies of updating data, incorporating new and continuing analysis, and exploring different spectrums of the recreation demand question.

The simple collection of facts and figures is not enough. The end should be an orderly classification and explanation of the interrelationships inherent in the figures. This explanation should be the central goal of a continuing program of recreation demand studies.

THE STUDY PROGRAM

The demand study should be performed as a sequence of individual studies or tasks. These should be coordinated and scheduled in such a way that the information needed for one task is generated by the preceding work, and should build

from work already performed or underway.

The major data generation phases will need to be initiated first. This will involve work on:

1. household surveys, in which recreation habits of Canadians will be determined;
2. park and recreation user surveys, to ascertain the nature of use of recreation areas of all types in all regions, together with characteristics of the users; and
3. recreation supply inventories, which will assess the extent and nature of recreation opportunities available to Canadians.

The subsequent phases will deal with analysis of the data and the determination of demand parameters. The program should lead to an assessment of relative demands and related needs and to the implications for planning recreation programs, policy formulation, and development strategy not only for the National Parks, but also for other recreation areas provided by all levels of government and private agencies.

Task 1: Recreation Participation Screening[1]

This portion of the study will focus on participation rates among various population segments in all regions of Canada. It will yield information on the proportions of the population which take part in recreation activities and visits parks of different kinds. This should provide initial useful data and be invaluable for structuring later tasks.

This study should be performed early. It can, in view of the lack of availability of Statistics Canada surveys, such as the Labour Force Survey, be most expediently done by existing market research firms who have well established population probability samples covering all segments and all regions of the country. These surveys, which are commonly done twice a year, are designed to include a range of questions serving various clients and can be augmented to include a small number of questions relating to outdoor recreation participation. It is of the highest priority, in terms of timing; the scheduling of later studies and the necessary sequencing require

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1. The flow chart for these tasks, prepared by Knetsch, along with relevant information on which tasks were carried out when, are found in Volume I. One may wish to look at Figure 1 and Tables 1 to 5 of Volume I.

that it be done in the fall of 1967.

Task 2: A Study of Motivational Factors

This study would attempt to isolate various motivational factors which are associated with participation in outdoor recreation activities among people in different socio-economic and locational situations. Activity participation rates vary enormously between different individuals. Part can be accounted for by differences in the opportunities available. Part can be explained by socio-economic variations. Yet major differences remain. The task study would seek to discern the importance of personality and other motivating factors which are linked to preferences for outdoor recreation. This can also best be done under contrast with existing market research firms. It would call for depth interviews with recreation activity participants and non-participants. It would be expected to provide direct input as guidance for structuring the household survey (Task 3) and to yield significant insight into the meaning of responses obtained in this and other segments of the overall study. It may well also have important planning and policy implications of its own.

Task 3: Household Survey

This study would be designed not to yield estimates of demands as such, but to give information on the habits and preferences of Canadians and on comparative participation rates among the population for various activities. It would be used to gain far more insight into the proportions of participants and non-participants among population segments than the initial screening study and would explore preferences of what people like to do, isolate factors which are associated with engaging in outdoor recreation activities, and investigate reasons for nonparticipation. Variations in participation among very broad regions will be investigated, although the sample size will necessarily be too small to make meaningful interplace comparisons among small regions. This is a fundamental and major weakness of this technique - to link adequately use or participation rate differences with differences in recreation opportunity. In this study, insight would also be gained into the demand for activities for which there is little or no opportunity.

There are many problems associated with these household surveys. The cost can be excessive if large samples and personal interviews are used. There are problems associated with mail surveys and with phone interviews as well. Furthermore, recall of number of days of participation or the degree of participation poses an additional problem in single interview surveys.

The use of survey panels of large numbers of individuals in all population strata in all regions of Canada which are maintained by market research organizations, offers a possible opportunity to minimize some of the disadvantages. For the immediate purpose, such panels, which can be resurveyed and are fairly representative of the entire population, may provide the most feasible alternative. If such a panel interview study is conducted, or if any other method is chosen, the consultation of Statistics Canada should be made an integral part of this phase of the work. Further work of this nature should also be coordinated with the Canadian Government Travel Bureau and the Canadian Wildlife Service, each of which have active program plans in the area. The design of the household survey should be carefully done and reflect the results of the initial screening and the motivational factor studies.

Task 4: ARDA Land Inventory

The next series of individual tasks relate to supply identification and structuring.

The demands for recreation opportunities need to be assessed against the background of existing areas and facilities. Details will be required on the type, extent of facilities and development, location, size and degree of access of recreation areas in Canada. The operation must have a high degree of uniformity of view and of classification across the whole country. The extent of the data collection can vary more than the classification scheme to be used and the kinds of data to be collected. A useful initial guide to classifying areas may be the existing Federal Provincial Park Classification Scheme.

Inventories are difficult to structure owing to the lack of standardization, the imperfection of quality determinants, the many individual attributes and dimensions of park and recreation areas, and the existence of a wide spectrum of types of areas and facilities to be included.

However, it is necessary to have available in a manageable data system information on existing present recreation supply. The demand study, by making explicit the supply data requirements, should aid materially in defining which inventory data should best be collected and its most advantageous form. The inventory work should proceed so that it continuously and successively builds on the initial data collected and assembled. The more complete the inventory, the more utility it has; but an incomplete inventory is still highly useful.

This task is concerned with the utilization of the Canada Land Inventory information system and with structuring of the supply determination effort. The initial task is to utilize and adjust the data to the Canada Land Inventory computer mapping program. This work is in advanced stages of completion and should be utilized as the basic framework for the inventory data. This program should provide a most useful base, first because of the classification data that may be a useful part of the inventory itself, and second, because of the associated development of map and computer techniques which appear to be invaluable to the organization of inventory and supply data. All of the inventory information should be keyed to the computer mapping unit by the utilization of map coordinate data.

<u>Task 5: Inventory of National Areas</u>

This task can be well done within the Federal agency. It involves an inventory of existing national areas relating to outdoor recreation supply. These data should be classified by type, characteristics, and locations. The initially required information should be readily available. It should be tabulated for each area with appropriate linkage for assembling into the data bank of the Canada Land Inventory computer mapping operation.

<u>Task 6: Inventory of Provincial Areas</u>

This task will need to be done by appropriate agencies of the individual provinces. The inventory task is similar to that for the national areas and each should maintain a high degree of complementarity to the others. While the inventories will need to be continually appended, the initial phases of the necessary assessment of

supply should be compiled within the first year.

Task 7: Inventory of Local Areas

The work contemplated in this task would supplement the other inventory work by providing information on many of the remaining recreation areas and facilities not included by national or provincial agencies. Many of the areas to be included are urban and regionally oriented. Private areas, to the extent that areas provided are of a nature that they directly and significantly affect the use of public areas, by their effect on the relevant supply, should also be inventoried.

Much of the work can be done by local agencies, with the possibility that some of it may be more suitable for outside contract. In no sense would the inventory be a complete one, particularly in the initial phases of the program, but even partial information on many of the areas would add materially to the necessary assessment of outdoor recreation supply in Canada.

Task 8: Coordinating Supply Data

This work, to be largely done internally, is one of coordinating the data collection and increasing the compatibility of the data collected from various sources. The various surveys or inventories may require somewhat different techniques and operations to acquire the desired data. The major objective of this task is to reduce the disparities into standardized format so that the data can be related to other survey results in the demand study.

Task 9: Review of Existing User Surveys and Data

This task would consist of an assessment of ongoing data collection programs involving recreation use of various areas and facilities and recreation travel. To be included, beside the considerable efforts of park and recreation agencies in all parts of Canada, are the work of the Roy Wolf Associates - DBS study of recreation statistics. Also of primary interest would be the highway origin and destination surveys, which are a continuing part of the highway and road development programs.

The applicability of the relevant U.S. surveys should be reviewed at this juncture. These would include any information that would supplement the Canadian surveys in the 1960 National Recreation Survey of ORRRC, the later one sponsored by the U.S. Bureau of Outdoor Recreation, and any surveys conducted in border states. The usefulness of the data and surveys should be explored but will likely be limited. One study, currently underway at Rutgers University, may prove of benefit because of the attempt to relate the participation data to supply characteristics. (see TN 34 for a discussion of their study.)

Task 10: National Park User Survey

This task, and the three to follow, focus on the collection of primary data on use made of existing areas and facilities. The purpose of this work is to collect data on the use and users of the full range of types of recreation facilities in all areas of the country; to assess the amount, timing and patterns of use of these areas and the characteristics of the users. This series of surveys will provide a major portion of the basic data for establishing recreation use relationships. This will enable predictions to be made of the consequences of varying the types or quantities of recreation activities or facilities. The work will consist of isolating recreation areas and facilities throughout the country in which a full range of the array of important dimensions of characteristics of recreation areas are covered, including types of areas, locations of areas, and administration of areas.

It is important that reliable total visit statistics be obtained for each of the areas investigated. Out of the totals a very small sample of visitors are interviewed using a short questionnaire. The samples need only be drawn on perhaps less than eight or ten days throughout the year, with only a fraction of the visitors on those days actually questioned. The questions asked are similarly limited, with average interviews lasting one or two minutes. The major concerns are with the trip origin, purpose, and limited information about the party. Efforts of this level in other studies have proven very satisfactory. Fully adequate methods are available which are relatively inexpensive, entail a minimum of difficulty at the site and to the park user, and yield meaningful results. The purpose of this task is to implement a system of gathering the

relevant data on visits and visitors to the national areas.

Task 11: Provincial Recreation Area User Surveys

The work to be accomplished in this task is to collect data on use of provincial areas parallel to that described for national areas. As the areas are more dissimilar and the data collected by different agencies, it is necessary that attention be given to careful design to assure that the results obtained from the different areas are fully compatible.

Task 12: Local Recreation Area User Surveys

The objective sought in this task parellel those of the preceding two series of surveys. The problems of uniformity are more severe and other problems will be more acute, but the requirement to obtain user data on local recreation areas remains. A representative range of condition of areas, facilities, and locational proximities should at the least be surveyed in each major region. These areas may well be among the most important in the total spectrum of outdoor recreation and have a direct bearing on the use of other areas.

Task 13: Border Exit Survey

An important segment of use of many areas, particularly in certain regions of the country, originates with visitors from outside Canada - primarily the United States. Among the surveys of use made of facilities should be included a border exit survey of a sample of nonresidents leaving the country. The information to be obtained would include the use which non-residents made of recreation areas within Canada, the type and location of areas visited, the number of times, and the purpose. This would afford a means of adding the non-resident dimension to the total demand picture. The border survey should be done in complete cooperation with the Canadian Government Travel Bureau. It can probably be most efficiently done with contract services.

Task 14: Participation and Supply Analysis

This and the following segments of the recreation demand study consist of data and program analysis sections. In each, the major efforts of data processing and analysis should be centered in one location, although parts may well be contracted out or otherwise separated. In each case duplicate data tapes should be made available.

In many ways the problems become more complicated after the data has been collected. While there is a good deal of theoretical work to draw on that is directly applicable, the attempts to quantify recreation demand have been of far more limited scope than those envisioned here. Attempts would be made in this task to gain insight into participation in outdoor recreation activities by different segments of the whole population. Data from the motivational study, the household surveys, and the inventory data, with some input for the user surveys, would be used to formulate broad relationships between participation rates and regional supply. Socio-economic factors measure to some extent the physical capacity to engage in recreation pursuits and the propensity to participate, but this is not enough for rational planning. The supply dimension, to be examined in this task, needs to be taken into account in explaining the observed use rates.

Task 15: Use Prediction Analysis

This task would use as primary data the results of the user surveys, plus the supply and participation analysis task. It is a major element in the entire study.

Use prediction models would be formulated, empirically relating recreation area use to the various factors contributing or detracting from this use, including such things as, the influence of proximity to population centers, the size of the area, the facilities developed, and the alternatives available in the same area. Also, degrees of substitutability between recreation areas would be ascertained utilizing this data. Estimates of how much may be expected to change over time, given changes in the population characteristics, and given changes in the supply configuration, would be formulated. The relationships established in the data analysis work of this task would form a primary means of assessing the outdoor recreation demands in

Canada.

Task 16: Assessment of Relative Demands and Relative Needs

The next analytical section of the overall study is concerned primarily with the assessment of relative demands and relative needs. Demand is not an absolute, but is a functional relationship between population characteristics and recreation opportunity. The whole outdoor recreation demand study will focus importantly on the assessment of relative priorities and investments and policies established on the basis of relative deficiency of supply to demands. The chief data inputs would come from the preceding analysis studies and the inventory data in the initial surveys.

Task 17: Development of Policy Programs and Strategy

The purpose of this task is to pull together the data which has been generated in the prior tasks, and to formulate the recreation policy implications, the recreation development program and the broad strategy for coping with the indicated recreation demands. There will be continuous flow of information useful for planning from many of the earlier steps, but the largest payoff will occur at this stage of the demand study.

It is anticipated that the program of studies outlined will provide the necessary data input for outdoor recreation planning processes to meet the multiple needs of the various agencies in Canada charged with recreation responsibilities.

Task 18: Continuing Data and Analysis Program

Planning for the provision of outdoor recreation opportunities is a continuous process. Similarly the data program and analysis should continue.

The initial round of surveys, data processing, and analysis can be fully expected to yield immensely useful planning, investment, management, and policy guides. The utility of this will increase, however, as the data becomes more complete, the survey operations and data analysis more routine, and the estimates more extensive and precise.

The initial round of studies should be initiated in the current fiscal year and programmed over the three fiscal years of 1967, 1968, and 1969. The efforts required will be substantial in terms of direct funding, staff of Parks Canada and that of cooperating agencies. There are various trade-offs that can be accomplished among these, but there are significant economies in having the work proceed in the manner described.

The demand study outlined can best be programmed in the following manner, with the professional staff requirements of Parks Canada and the direct outlay of funds which will be needed to carry out the individual tasks noted for each segment. These estimates of staff time and funds can vary greatly and should be regarded as very approximate at this stage of program planning.

Tasks to be initiated in 1967 include the following:

Task 1 - work on the preliminary recreation participation screening should begin in the fall of fiscal year 1967. It is anticipated that staff time required would be approximately one half month, the cost in this year, $15,000.

Task 2 - the motivational study, should be initiated during this fiscal year. It is anticipated that this would involve one half month, and $15,000.

Initial inventory coordination work should be begun. This would be in connection with Tasks 4, 5, 6, and 7. The staff requirements here may be expected to be approximately two months, excluding work by the personnel at ARDA, and funds would be approximately $5,000.

The review of user data and statistics, Task 9, should be carried out during this fiscal year. The time and costs requirements are anticipated to be three months and $2,000.

The initial planning for user surveys should also be initiated during fiscal 1967. It is anticipated that this would take three man months of staff time, and approximately $9,000 in expenditures.

The total staff time requirements for the projects which will need to be initiated during the current fiscal year are approximately nine man months; the total fund requirements are anticipated to be $46,000.

The work to be undertaken in fiscal year 1968 includes the following:

The motivational studies, Task 2, should be completed very early in fiscal 1968. This will involve one man month of staff time and $10,000.

A household survey should be initiated during fiscal 1968. It is anticipated that the Canadian Wildlife Service, the Canadian Government Travel Bureau, Statistics Canada and perhaps others, would be involved in this effort. Staff time required of Parks Canada is anticipated to be four man months; expenditure of funds is expected to be approximately $50,000.

The inventories should be carried along. Staff time required during this year is four man months; the expenditures needed may total $8,000.

The user surveys, Tasks 10, 11, and 12, should be carried on in an extensive manner during fiscal 1968. This will necessitate substantial staff time and includes expenditures for computer time, road counters, and supplemental field personnel. The staff time involvement is anticipated to be 15 months, and the expenditure $60,000.

The border exit survey should be carried out during fiscal 1968. This work, Task 13, will involve, in addition to the Canadian Government Travel Bureau people, one man month of time of Parks Canada, and perhaps $5,000 in funds.

The analysis of participation data and user data, Task 14, should be well underway in fiscal 1968. This will require 13 man months of staff time and $25,000 in expenditures.

Task 15, the formulation of use relationships should be initiated during this period. This effort will require 2 man months and $3,000.

The total staff time required in fiscal 1968 is approximately 40 man months; the total expenditures of funds, $161,000.

The work in fiscal 1969 should include the following:

The user surveys, including border crossing survey, should be continued. This will involve ten man months and $30,000 in funds.

Inventory accumulations and refinements should be

continued in 1969. This will involve three man months and $10,000 in expenditures.

The analysis tasks should be well underway in fiscal 1969. These would include the analysis of participation supply data, Task 14, the analysis of visitor use data and formulation of use models, Task 15, and the assessment of the relative needs and demands, Task 16. This work will involve 22 man months, and $30,000 in funds.

The development of program strategies and policy implications will be carried on in fiscal 1969. This will involve five man months, and an expenditure of $20,000.

The total for 1969 for the work anticipated would involve approximately 40 man months and expenditures of $90,000.

The total expenditures anticipated in the initial three year effort in the series of demand studies would be $46,000 in fiscal 1967, $161,000 in fiscal 1968, and $90,000 in fiscal 1969, or a total over the three year period of $297,000.

The demand studies are designed for a continuing program of surveys, and continuing development of the analysis is anticipated. The subsequent cost might run approximately $30,000 for the surveys, and another $30,000 for the analysis and development work, or something in the order of $60,000 in fiscal 1970.

The program which is envisioned will require that Parks Canada acquire additional staff whose major responsibility is the coordination of the demand studies and major participation in the analytical work. It is highly desirable that the personnel undertaking this work have qualifications in analytical methods. This would include econometrics, statistics, and familiarity with computer techniques. It is anticipated that four people should have major assignments over this period of time to work on the demand study.

INTRODUCTION

This paper was prepared by Knetsch in 1969-1970. At that time, the Canadian Outdoor Recreation Demand Study analysis Group within Parks Canada was being formed and such a paper was needed to give guidance in the analyses of the CORD Study data. Presenting this Working Paper in a slightly edited form affords researchers and research analysts opportunity to develop insights into how ideas have evolved and how quantitative advancements have been made.

In the view of major contributors to the CORD Study the Working Paper was (and still is) a useful and provocative document for understanding the thrust of continuing research efforts. This edited version includes references to a number of Technical Notes. These Notes concern analysis efforts carried out long after the original paper was prepared. The references are offered to the reader as evidence of Knetsch's insight into the direction that anlysis had to go. Certainly, if the reader accepts the evidence, the paper provides a fitting introduction to the rest of this volume.

WORKING PAPER: OUTLINE OF DATA ANALYSIS ASSESSING OUTDOOR RECREATION DEMANDS

J.L. Knetsch

(with editing and updating by J. Beaman)

ABSTRACT

This paper was originally a series of notes on how the CORD Study research should proceed. It expands on an earlier paper by suggesting how to carry out tasks which were called: (14)Particpation and Supply Analysis and (15)Use Prediction Analysis.

Initial discussion of what is meant by outdoor recreation demands is presented to provide a rationale for further discussion. Some of the major analyses that are proposed are then outlined, using examples to illustrate the methods of analysis. As well the presentation contains: (1)a set of points on the use that can be made of the results of the investigations proposed, and (2)some indications of future research directions that might be considered when the main approaches suggested have been followed.

THE NATURE OF DEMAND

There is but little doubt that one of the most important and productive tools of economic analysis is the notion of demand. It can be of immense usefulness in determining consistent and rational outdoor recreation policies and in determining how we can best utilize and manage recreation resources. If demand relationships can be understood with even a modicum of success, various kinds of productive analyses are possible that provide at least partial answers to many difficult problems. This is not to suggest, as was pointed out in the original design paper, that demand analyses can provide clear-cut answers to planning problems. They cannot. Rather, it is to suggest that demand analyses can provide important information useful for planning and policy decisions.

There has been much concern with the trends of recreation use of various facilities. In part, these reflect increases in the demand for outdoor recreation facilities and areas. There has been considerable ambiguity connected with the usual statements used in explanation of these. Further, knowledge of these trends does not solve the problem of how best to accommodate the demands for outdoor recreation. In fact, parochial recitation of the number of recreation visits accommodated each year clouds the hard issues of how much recreation, and of what sort, should be provided. (For trends, see TN 13 and TN 22.)

There is further confusion between the statements of recreation consumption (which are the number of visitors we observe) and the demand for a commodity. In a similar vein there is often confusion between the need for commodities or services such as outdoor recreation and the demand for it. Need, as often expressed, designates a capacity of some sort judged to be adequate to accommodate some forecast for a given target year. Often funds are appropriated to individual jurisdictions in accordance with such estimated needs. However, this can have a perverse influence on the rational provision of outdoor recreation facilities. Demand for, or more correctly the use of, a facility is often far more a function of its availability. Increasing the opportunities, therefore, may merely stimulate more of the same type of facility use.

This type of difficulty pervades not only recreation planning but other public expenditure categories as well. An example of equating need with use forecasts is that of the highway program in the U.S., where a highway travel report estimated that there is a "need" to devote 320-billion dollars to road construction over the next 15 years. It would have been more useful to ask what parts of this total highway "need" offer a return sufficient to justify expenditures of public funds. In other words, with a clear determination of the demand, one could make a more rational estimate of the different consequences of alternative actions or levels of spending - far more useful information on which to base highway plans.

The most important characteristic of demand, and how it is to be used in recreation planning, is that it is a conditional or functional statement. That is, it is not an absolute number but a magnitude dependent upon the levels of other factors. In general, demand for any commodity springs from the notion that a consumer making a purchase does so because he feels that it will serve some real or fancied use. Consumers express their wants and desires by expressing different demands for different commodities. The consumer often desires more of many goods and services, but is constrained by income levels. Consequently, his demands for different commodities express relative preferences among commodities, given income constraints. In an economic system based on market forces, knowledge of these demands serves to inform producers of the relative quantities of different commodities that can be profitably marketed.

The demand for commodities is the amount which purchasers choose to buy. However, this amount is determined by factors that limit demand. For most goods and services, the lower the price the more will be demanded by any single individual and by the market - the collection of all individuals.

The income of individuals is also a factor. Normally, and there are exceptions to this, the higher an individual's income the greater the quantity of individual goods and services he will demand. A third factor is the price of closely related commodities, the substitutes and complements of the goods in question. The demand for goods can be highly sensitive to changes in the price or the availability of other goods. In the case of other, the demand is nearly invariant. Necessities characterize the latter group.

A fourth factor that must be considered is the tastes and preferences of the individuals, in other words how they make up their minds, their attitudes, their adherence to fashions, customs and so forth. Tastes and preferences are usually taken as "given" in economic analyses with a focus on the consequences of economic factors that influence the demand for any given commodity. The concern is with HOW consumers make up their minds in terms of the quantities which they demand of different goods and services, not with WHY and how they make decisions. With most analyses there is no particular interest in explaining choices, but merely in determining what the reaction is and how it will change, depending upon change in economic factors of price, the availability or price of substitutes, and incomes. Consumers make choices among different commodities and when circumstances change, their choices reflect this. The patterns of choice are particularly apparent where consumers are viewed as groups, minimizing the influence of individual deviations.

In the case of outdoor recreation, the principles just outlined still supply. The difference has to do with the individual conditions. Tastes and preferences of individuals are a factor with regard to recreation just as they are with regard to the demand for any commodity. The

income of individuals is similarly a factor. Higher incomes usually result in greater demands for most recreation services, although here again there are exceptions and these may be important to know about. Skiing is undoubtedly highly responsive to income changes; hunting is likely to be far less so and may even be negative. Regarding alternative commodities, the relative availability and accessibility of substitute recreation areas or other substitute demands for time and money have an effect on the demand for any given recreation site or any recreation opportunity.

It is in the area of price that the demands for outdoor recreation and the demand formulations for most commodities differ. However, it is a difference in particulars and not a difference in principles. The role of price vis a vis recreation is usually covert. For a variety of good reasons we generally make outdoor recreation opportunities available publicly - outside the market conditions. Although the private market does exist, it usually does so for a fairly small range of recreation facilities and services, with the bulk being provided publicly.

Fees and charges, even though used to a certain extent in public areas, are not normally prices which serve the usual market function of allocations. Instead, in recreation the price variable (in terms of a demand analysis) largely pertains to the relative availability or accessibility of recreation opportunities. This availability is often measured in terms of locational proximity although other measures or determinants of availability exist as well. (see TN 5, TN 17, TN 25.)

Thus when one speaks of the demand for outdoor recreation, the statement is one of "condition" and is, in principle, similar to statements about scarce commodities generally. The factors determining them remain the same in principle. It is only in the particulars that the formulations differ. The role of proximity to "need" is far more important than for most consumables. This partially stems from the non-market nature of the demands. In part, however, it also stems from the immobility of most resources used for recreation purposes. This is a characteristic somewhat peculiar to recreation. Recreation activities are consumed at the site rather than purchased and consumed more ubiquitously.

AGGREGATE DEMAND ANALYSIS

Given the general nature of demand, and in the specific context of outdoor recreation, a series of what might be termed aggregate demand studies can provide important insight into the characteristics of the demand for various kinds of outdoor recreation services. The emphasis of such studies is upon the determination and explanation of the variation in the amount of outdoor recreation demanded by different segments of the population. (see TN 6, TN 12, TN 13, TN 20, TN 29, TN 33, and TN 36.) Such studies differ

from investigations concerned more with the demand for a certain outdoor recreation facility, or a given recreation area such as a park. (see TN 1, TN 4, TN 7, TN 8, TN 11, TN 14, TN 18, TN 19, TN 30, TN 31, TN 33, TN 34, TN 35, and TN 38.) Studies also focus on allocation or setting up economic accounts. (see TN 5, TN 17, TN 25, TN 26, TN 32, TN 39, TN 40, TN 41.)

The major intent of aggregate studies is to relate participation in the various forms of outdoor recreation to a range of socio-economic variables and supply characteristics. The basic analyses consist of obtaining data on participation of different segments of the population in the different forms of outdoor recreation and then attempting to explain these variations in participation rates in terms of both the different supply characteristics facing these different individuals and their differing socio-economic attributes. The underlying notion is that the rates at which individuals in the population participate in various forms of recreation is dependent, first of all, upon such things as their income levels, their education and so forth, and also upon the availability of opportunities of various kinds. For such analysis to be meaningful information is needed on a cross-section of the population to identify the characteristics of the individuals and the rates at which they participate in different recreation activities, as well as something of the different opportunities that may confront them. For example, one normally would expect to find that the rate at which different members of the population participate in skiing is somewhat related to their income levels. This is explained by the necessity to purchase equipment and other expenses attendant on this type of activity. So normally we would find that higher income levels are associated with higher rates of skiing activity. Similarly, we would also expect to find that the visits to (for example) National Parks are dependent upon the distance of different individuals from such areas. In aggregate demand studies it is the characterization of these relationships which are of primary interest.

These studies are useful in examining the population as a whole and the variation which this population exhibits with respect to its outdoor recreation rates among populations living in different parts of the country, in rural areas versus large metropolitan areas, and between high incomes and low incomes. While socio-economic characteristics may be predetermined and fixed for most planning questions, supply characteristics are not, nor are they policy determinations for providing outdoor recreation in the future. Participation information can be expected to be useful for deciding a number of broad planning and policy questions. For example, if it is found that individuals of given locational or socio-economic characteristics are participating at far lower levels in certain activities than others, there may well be an effort made to make facilities more available to them, assuming the lower rate does not

reflect lower preference for that activity. (On the subject of CORD Study supply data, see the CORD Study Data Documentation.)

DEVELOPMENT OF DEMAND ANALYSIS INQUIRIES

Demand analysis can proceed on two basic fronts. In the first, the emphasis is placed on fairly simple and straightforward tabulations and cross-tabulations of participation in various forms of outdoor recreation and the different characteristics of the population. Some of this has been done in the case of the original report from Canadian Facts. From this series of tabulations a number of gross indications of differences in participation rates becomes evident. In many cases the explanations may be fairly readily understandable, while in others they will be less so. In par, they may be attributable to differences in characteristics of populations and in part they are due to differences in supply availability . Large differences will remain as yet fairly indeterminate. Still, it is useful to know, for example, the participation rates in large cities as compared with participation rates in small cities and in rural areas, and also the variation in participation in different activities in different provinces. (See the discussion of the CORD Study National Surveys in Volume III: Data Collection and Documentation).

A second type of analysis relates the differences in participation to various associated factors in a more systematic and analytical manner. The best example of such a study as of 1969 was that reported by Cicchetti, Seneca and Davidson, hereafter referred to as the Rutgers' Study. For elaboration of that work one may see Cicchetti's new book. The data of the Rutgers' Study were obtained from a most ambitious data collection program. Unfortunately, the scarcity of adequate supply data and the meagre ability to formulate meaningful supply variables proved a severe deficiency. The supply information used was very crude. Nonetheless the study did utilize several supply variables which provided meaningful answers and, perhaps more importantly, provided a demonstration of a methodology that could be applied to the CORD Study program. The Rutgers' Study set out to explain participation rates using a two-step procedure. First, a "conditional probability" for participation in a specific activity was developed in relation to socio-economic and supply variables. (see TN 12 and TN 28 for similar CORD Study analysis.) The aim was to determine if a respondent was a participant or not: that is, whether he had, during the course of the year preceding, engaged in particular outdoor recreation activity for which a predictive equation was developed. There was no attempt to indicate whether or not a single individual would participate in a given recreation activity; instead the focus was on the probability of his being a participant dependent upon the level of the explanatory variables.

Data was readily at hand for the socio-economic variables. For the supply variables, it was necessary to depend on a crude set of variables obtained from available 'inventory work'. Some general inventory results were the supply information for the empirical work. There were some data on the number of facilities of various kinds by country throughout the U.S. To use these data, respondents were identified by country of residence and thus inventory data were linked with the county of the respondents. This type of supply variables included:d: distance from large bodies of water (by 50 and 100 mile groupings), recreation land acreage, wetland acres, water acres, water acres by class, and acreage of various Bureau of Outdoor Recreation classified lands.

There were also data facilities on a state-by-state basis. These proved to be less useful than those by county, but some of these data were used. They included the number of swimming pools, the number of sports establishments, the number of golf courses and numbers of other commercial establishments.

In the Rutgers' Study, the probability of a participant engaging in swimming was found to be dependent upon the following variables in a statistically significant way:

> age of the respondent, race, sex, size of the population unit in which the respondent usually resides, education level, family income, owner or renter of the domicile of usual residence, size of the family, number of children from ages 6 to 11, region of the country, occupation of respondent, class of work of the sample person (self-employed or not), occupation status (blue collar, white collar), population of the sample unit, population of the state, distance from the ocean or Great Lakes, receipts of recreation and amusement establishments in the area in which the respondent lived, number of commercial recreation facilities, population density, median income of the state.

If all members of the population were faced with approximately equal supply configurations, supply variables would not be expected to be significant. However, this is not likely to be the case for most forms of recreation. For those in which access to an opportunity is an important determinant, and for which the spread of the opportunities is uneven, supply variables take on increased importance. (see TN 29.)

Having determined the conditional probability of participation the analysis then proceeded to a second step of determining the degree of participation for all of those individuals previously identified as being participants in a particular activity. That is, given that their activity level is greater than zero, all respondents qualifying on these grounds were then subjected to a separate analysis in which the level of participation was analyzed. A series of

variables was related to different participation levels and an attempt was made to establish significant relationships between these variables and variations in participation levels.

This two-step method proved to a very useful one. It overcomes many of the problems that occur when there are a large number of non-participants in an activity. Furthermore, it allows for different equations to be calculated to explain different levels of participants. It would be expected, for example, that different variables would explain whether a person is a participant or not and determine the level at which a participant engaged in an activity. Not only would there be different variables that would likely be important, but also the relative importance of variables that were important in both cases should differ. There were various difficulties encountered with explanation of the sign of individual variables, whether a factor contributed positively or negatively, but on the whole the analysis proceeded in a fairly straightforward manner.

The Rutgers' Study was thus successful in establishing a useful methodology. It was also useful in pointing out a number of empirical findings that will be of great interest to planners dealing with recreation problems, although the degree of explanation was in some cases disappointing. Future analysis attempts should prove to be more successful. For all of the different recreation activities investigated such factors as age, income levels, race, sex, education, home ownership, family size and composition, region of the country, occupational class, population size in the local area, and distance from major recreation opportunities were found to be the most significant. (For similar results, see the Appendix to TN 12, available through the LEISURE STUDIES DATA BANK, Waterloo Research Institute.)

Given some quantification of the relationship between participation in the various recreation activities and various factors that are found to be associated with them, projections of future recreation demands are possible. Such estimates can be made from projections of future populations and their socio-economic characteristics, given some assumption concerning the future supply configuration. The most useful of such projections would be those obtained under different levels of future supplies of recreation facilities. Comparisons of future activity under different assumed supply conditions would give some quantitative information to policy planners in assessing current development and also in deciding among levels and types of future expansion. (see TN 12, TN 13 and TN 29 in particular.)

In the Rutgers' Study, two levels of future demands were used to illustrate the methods and results. The first assumed a future pace of expansion of supply of recreation opportunities comparable to current allocation. The second assumed a more ambitious rate. For example, the swimming equations for the northeast region of the United States

yielded the following forecast. It was estimated that in 1965, the year of the survey, approximately 350-million activity-days of swimming occurred. Under the first assumption of more limited future recreation development, the projected activity-days of swimming in the region (given the projected population and other characteristics of that population) are 450-million days in 1980 and 740-million days in 2000. Under the more expansionist assumption for future development, the projections are for 630-million days in 1980 and 890-million days in 2000.

Needless to say, the quality of these projections is dependent upon the quality of the data and on their analysis. (see TN 6, TN 20, and TN 35 on accuracy and other problems.) In the case of the Rutgers' Study there were well recognized limits, particularly with respect to the quantification of the supply variables. The deficiency in characterization of supply is particularly troublesome when, for most activities, the demonstrated importance of the strong effect of proximity to facilities is considered. The shortcoming is particularly important when attempting to discern differences in future demands, as they may vary depending upon the levels of provision that are made available, in particular regarding supply measurement in relation to facility provision and proximity. (see TN 5, TN 16 and TN 17.)

There are, of course, certain limits to the usefulness of the analysis in a study such as the Rutgers' effort. However, their general procedures and analyses are well worth imitation. There is much insight to be gained from such a study in terms of both an indication of future demands and in a fuller appreciation of the various factors that influence recreation behaviour among the different segments of the population. (For an integrated CORD Study perspective, see TN 33.)

SITE DEMAND STUDIES

There are a number of policy, planning and, to some extent, management questions on which the more aggregate demand studies can provide some useful insight. There are others, however, on which guidance related to more specific sites or to alternative areas is desirable. For example, if more efficient and orderly development of future recreation areas is to be attained, guidelines will need to be developed to predict the likely use of alternative locations of facilities and types of development. (see TN 3 on alternatives and TN 33 on the integration of a Rutgers'-type model with a destination area oriented model.) Estimates of the amount of recreation use that can be expected at a particular site, or alternative sites (given proposed or known characteristics of the users) are necessary. The estimated use figures should reflect the effect of planning variables such as the location of individual sites, the type of development carried out, and the competing opportunities

available to the relevant populations as well as something of the socio-economic characteristics of these populations.

The estimation procedures used to project recreation visits or levels of use of a given recreation area are based on quantifying the relationship between observed use of recreation sites and the various factors that influence this use. The suggested procedure makes use of visitation data from a number of sites, for example a series of parks from a provincial system. Using fairly standard and straightforward multiple regression methods, one may determine which of a number of different variables are significant determinants of facility use and their contribution or weight in determining this use. (For some considerations see TN 19 and TN 35 on the need to use other methods than "simple" regression.) These factors would normally be expected to include such things as the distance of the site from population centres of various sizes, possibly a number of socio-economic characteristics of these populations, some characteristics of the sites, and the alternative recreation opportunities that may also be available to the users and potential users.

It would be expected, for example, that all other things being equal, a park nearer to a population centre would draw more visitors than one which is more distant. In such a case it is the negative effect of distance that brings about the difference in the attendance between the two. With observations on park use from a number of such sites, a pattern would normally prevail in which the use levels would show a fairly consistent reduction with increased distances. If the distance effect is significant, as one would normally expect it to be, the degree of importance, in terms of how much reduction would be expected per mile or per hour, can be estimated. (On the effect of distance, see TN 14.)

If there were only the distance factor to consider in making use estimates for a new park, they could be made graphically by plotting the observed points, drawing a curve, and reading the use of a new park off the resulting graph. Alternatively, when more variables are involved, much the same thing can be done by statistically estimating the coefficients or parameters of an equation that can be employed to predict use.

The general procedures can be illustrated by an example. The United States Army Corps of Engineers operates a series of reservoirs throughout the United States, many of which receive extensive recreation use. Consider seven reservoirs in the Sacramento district of the Corps for which these use data were collected over four years, 1966 through 1969. During user surveys, interviews were conducted with approximately 40,000 visitors on their party's visit to these sites. While the data were collected on both day-users and overnight visitors, analysis was carried out only for day-users, that is, people visiting the site but not remaining overnight.

The origins of the visitors were classified into area

groupings based primarily on county or parts of county units. Incidentally, some earlier analyses have used concentric rings around sites as the unit of observation. The county units, however, while introducing more variations in the data, allow more meaningful locationally specific variables to be measured. As distance from the reservoir increased, the size of the origin area unit used in the analysis was also increased (see TN 1 where this analysis procedure was followed very closely). The number of areal units that were taken as being the points of origin for each of the reservoirs varied from 22 for Isabella reservoir to 26 for Pine Lake and Success reservoirs. In all, a total of 168 observations of origin to lake destinations flows were used in the analysis of the visitor characteristics for the seven reservoirs.

A number of independent variables were used in attempts to explain the variation in the observed visit numbers from each of the origins to the lakes. One variable included was the road miles from the areal unit of origin to a reservoir of destination for a visit. The origin was taken to be the population centroid of the "general" origin area. It was, of course, expected that, as this distance became larger, the number of recreators making the visit to the particular site would decrease. A second variable was the population of the origin units. No data were collected on the incomes of the visitors but average per capita incomes were a variable defined for each origin area.

The size of the reservoir measured in acres of the recreation pool was also a variable used in the analysis. A size indication was deemed necessary to account for the increased capacity of the different reservoirs. This was also considered a crude measure of the attractiveness of a recreation site. (see TN 9 and other work cited there.) A number of alternative size or capacity variables were included in the analysis but ultimately only gross acreage was kept because it proved to be as good as any other transformed acreage variable in this case.

Another variable was included to account for the alternative recreation opportunities of a similar nature available to residents of the various population origin areas. It would be expected that if readily available substitute areas were available to a population in a given area, fewer visitors would be inclined to make the trip to the reservoir in question than if substitutes were not availble. (see TN 1, TN 3, TN 11 and TN 33, also, on substitutability, see TN 32 and TN 37.) The variable to measure is one that accounts for other lakes and reservoirs, with the value being larger as the number of lakes available to a population increased and larger with their proximity.

The equation which was finally derived based on the observed visit patterns was as follows:

$$V(i,j) = -3303 + (P(i)/D(i,j))\,(2.09 - (.24)\,(W(j)^{**}1/2)) + .0037\,W(j) + 28.79/A(i)^2$$

WHERE

V(i,j) = number of recreationists going from population centre i to lake j,

P(i) = the population in the areal unit i,

D(i,j) = distance between the population centres and the reservoirs,

W(j) = size of the recreation pool in the individual reservoirs, and

A(i) = measure of alternative lakes and reservoirs available to the different populations.

The variation among the area units proved insufficient to obtain reliable estimates of the coefficient so this variable was dropped from the analysis. Had income data on the visitors been available it might have been possible to relate the number of visitors from each of the counties to each of the lakes by income.

Nevertheless, all the individual coefficients are significant at the one percent level. This expression accounts for or "explains" approximately 94 percent of the variation in visitor totals among the observations. That is, of the variations in the individual visit totals among the 168 observations, all but about six percent is "explained" by this equation. (On the meaning R^2 and how regressions should be carried out, see TN 19 and TN 35.)

In the case of the reservoir study the emphasis was on predicting use for a new reservoir. Because of the nature of the existing lakes and the anticipated nature of any new reservoirs, there was little need to concentrate undue attention on individual lake characteristics. Undoubtedly the lakes differ somewhat but as in the case of most recreation areas, to predict their use well, more detail (or rather how they differ in terms of specifics) would no doubt be required. Ultimately, this must be subjected to empirical investigation. (On how attractivity relates to park characteristics, see TN 4.)

While distances were measured in road miles in this study, improvements may have been possible with the use of travel time. It may also be noted that the reservoir model was for one type of recreator - the day visitor. Analysis of visit relationships for overnight visitors would need to be done in an analogous manner, but separately. It would be expected that different variables might well be important and that even the coefficients or parameters of the same variables would differ: the effects of distance on the camper will not be the same as they are on the day-use visitor. In the case of the Canadian parks it would seem reasonable that a similar separation of visitor types should be made for analysis purposes. (see TN 30, also TN 18 on enroute visitors.)

In these cases, there is the further matter of considering substitute or alternative areas. In the reservoir study, only other reservoirs and lakes were considered as substitutes - as indeed they no doubt are. However, other areas may also be important in this regard.

Proximity to the ocean or to the mountains or to Las Vegas might have been tested. In regard to provincial parks there is usually a range of areas that should be similarly tested. (see TN 37.)

CONCLUSION

The range of consideration in demand analysis is wide. In some useful studies the variables are few and the models simple: this was true for the reservoir study but less true for the Rutgers' Study. Ultimately, a far greater number of concerns will need to be dealt with effectively. Income and population changes are certainly important in some studies and here more information is desirable on how use varies with these factors. (see TN 12 and TN 13.) How attendance figures may be expected to change over time may be important (see TN 7.) Simple formulations may be used to answer fairly broad questions, but detail is necessary to provide guidance for more precise planning. In this regard an analysis is largely open-ended.

It is the last point that best typifies the type of analyses being suggested throughout. It is not really that it is never ending, but rather that different kinds and depths of analyses may be used depending upon the problems being confronted. And, of course, initial analyses will suggest further questions. While unexplained variance or (more euphemistically) 'unknowns' will persist and call for judgement based on the experience of planners, the chances of helpful guidance stemming from such quantitative study is a certainty.

CHAPTER II

DESTINATION MODELS

Introduction

The first analysis effort conducted within the CORD Study was the development of destination models. Cheung's work on a model of visitor flows for the day-use of parks began in 1970. His model is presented in TN 1, A MODEL FOR ESTIMATING DAY-USE OF PARKS. TN 1 was important in the development of TN 7, AN APPLICATION OF MATHEMATICAL MODELS TO COMPARE TWO POTENTIAL PARK SITES.

Concern with overnight-use of parks arose early in the CORD Study. Shortly after Cheung began work on a day-use model, it was recognized that if CORD Study analyses were to be of broad importance in Canadian outdoor recreation planning, it would be necessary to develop models that would allow the prediction of the volume of a number of types of recreation use of parks, including overnight-use. For this reason, a contract was initiated to develop a work plan for a mathematical model to predict overnight-use of parks. Unfortunately, this work did not proceed beyond the stage of model development. Problems with the CORD Study Park User Surveys prevented the work plan from being initiated. Nevertheless, CORD Study TN 30 presents ideas on 1) the need to disaggregate visitors into various classes, and 2) the kinds of models that are appropriate for different classes of visitors.

At about the same time that work on TN 30 was initiated, a proposal was received to develop a model for estimating park attractiveness and population centre emissiveness. Cesario proposed the development of a new modelling concept that appeared to have great (but unproven) potential in the analysis of certain recreation travel problems. When Cesario sought support to develop the model, it was throught that the CORD Study Park User Survey data would not be satisfactory for building the proposed model. In fact, because of data problems, the initial proposal was held in abeyance. But, eventually the development of an attractiveness-emissiveness model was pursued as a CORD Study project and resulted in TN 4. The Cesario modelling project made little use of CORD Study data. Instead, accurate data on camping were obtained from the province of Ontario.

By its very success, the Cesario modelling effort raised unexpected questions that became the focus of concern in other Notes. Specifically, Cesario defines what he calls the attractiveness of parks and the emissiveness of origins. These concepts give rise to questions about what attractiveness and emissiveness really are. Attractiveness is discussed in Chapter III. One issue regarding Cesario's

emissiveness is whether it is a property of a city, or whether it is also related to the configuration of supply that occurs around the city. TN 11, which was one of the last Notes prepared, presents proof that Cesario's emissiveness is not a simple concept. Rather, it is suggested that the emissiveness of a city is generated by its inherent emissiveness and the effect of alternative sites around it. The last Note prepared, Technical Note 33 (Chapter IX), also deals with emissiveness and pursues the meaning of attractiveness in the Cesario model. It also shows how a generalized Cesario model "integrates" much of the work presented in this volume.

CORD STUDY TECHNICAL NOTE 1

A MODEL FOR ESTIMATING DAY-USE OF PARKS

H. K. Cheung

ABSTRACT

One aspect of rational park planning is developing site-specific models that give insights into the structure of relations that determine participation at a given park which is part of a system. This research reported on was carried out to obtain a conceptually and structurally more meaningful site-specific model (often called travel model in the literature). The model developed is site-specific in that it deals directly with use of twelve individual sites in Saskatchewan. Alternative recreation opportunities and park attractivity are related to quantitatively defined explanatory variables considered in formulating an appropriate estimation framework.

The alternative factor use is defined in terms of the location and the number of alternative sites available to the visitors to a particular site, while attractivity is expressed as a function of the physical characteristics of the facilities and the services offered at the site visited by a party from which information was obtained.

The data for this study were collected as part of the CORD Study 1969 Park User Survey. The paper does not provide details about the survey but documentation on it is available elsewhere.

Multiple step-wise regression was used to derive a relationship between total season attendance figures (the dependent variable) and the explanatory variables - population, distance, alternative recreation opportunities and attractivity. The results indicate that a particular combination of the variables population and distance explains a large amount of the variance in the Saskatchewan day-use data for the 12 parks considered.

An application of the model to determine a desirable location for a new park is given as an illustration of the usefulness fo the model to planners and managers.

INTRODUCTION

During the past decade many investigations have been conducted into the use of outdoor recreation facilities to determine a quantitative relationship between park use and its key determinants. Much work has been done on determining functions that best express the "inhibiting force" of distance and travel time. In their reservoir studies, Ullman and Volk (see Reference 35) found that per capita

participation was related to distance raised to a power ranging from two to four. Other references to the investigation of the effect of distance on trip movement can be found in References 21 and 33.

Studies considering the effect of intervening opportunities (for original formulations of the theory see References 33 and 34) and site attractiveness are relatively rare. In the Texas reservoir study a number of explanatory variables, including a "gravity" variable, were incorporated into a double logarithmic regression equation and were found statistically significant in explaining the number of visitor days from a county of origin to a reservoir per unit time. The gravity variable, defined as the common logarithm of reservoir size divided by the distance between the reservoir and an origin, was designed to reflect the competitive effect of other reservoirs located within a 100 mile radius of the population center of each county. A modification of this approach was adopted for the model that is presented here.

Clawson and Knetsch (see Reference 11) suggested the possibility of developing specific, and rather objective, rating scales to measure the attractiveness of outdoor recreation areas. Van Doren (see Reference 37) devised a camping attractiveness index for each of 59 Michigan state parks. His index was based on 55 variables related to (1) outdoor recreation activities, (2) natural environmental resources, and (3) camping facilities and services. Rather subjectively determined values were assigned to each of the variables. Factor analysis was employed to derive aggregate scores for the variables belonging to (2) and (3). The camping attraction index of a park was a weighted combination of its scores on the individual variables. Another formulation of the attractiveness index (see Reference 37) simply considered the type, quantity and quality of facilities offered and was defined as a sum of products. The "utility" of having an activity and the quality of the activity were multiplied and this product was added for a set of activities. This form of the attractiveness measurement does not require data as elaborate as that required by the Van Doren approach and thus is convenient in analyses where only limited data are available, as was the case in this study.

In California, Pankey and Johnston (see Reference 27) found that prediction precision was gained by estimating day-use and overnight-use separately and using the sum of these quantities as the prediction of the total use. The approach of disaggregating users was followed in this study. The study, however, deals exclusively with main-destination day visitors, defined as those who go to a park as their sole trip purpose and return home on the same day.

DATA COLLECTION

A visitor survey conducted in a number of Saskatchewan

parks during the summer of 1969 constitutes the data base for this study. The survey methodology used to obtain the data was similar to that described by Crapo and Chubb (see Reference 13). Handback questionnaires in card form were distributed according to a probability formula to visitors entering parks through access gates during daylight hours. These cards were distributed by either a special survey staff or park attendants. Retrieval of the cards was accomplished by voluntary deposit in collection boxes placed near the park exit gates. The overall return rate was about 56 percent.

The information gathered can be divided into three categories. The first class of data concerns user characteristics, such as party composition, family income, occupation, and education. The second deals with facilities used: examples of these are the picnic ground, the bathing beach, and the hiking trails. The third pertains to travel characteristics, chiefly visitor origins, purpose of trip, and length of stay in the park. Only the last class of information was utilized in this study.

The formula used to obtain day-use estimates is described in the version of of this article which appeared in the JOURNAL OF LEISURE RESEARCH (see Appendix B).

Specification of the Model

A generalized outdoor recreation travel flow model was assumed to have the form:

(1) V(i,j) = f(O(i), D(i,j), S(j))

WHERE

V(i,j) = number of "visits" from origin i to site j during some finite time period,

C(i) = characteristics of origin i, such as the size and the socio-economic characteristics of the population,

D(i,j) = a variable to account for the effect of the spatial separation of origin i and site j, and

S(j) = the characteristics of site j, such as the natural features and the man-made facilities at the site.

For the sake of convenience and simplicity, linear regression was selected as the tool of analysis. An additive model and a multiplicative model fitted in logarithmic form were considered; the former was chosen even though the latter may have some desirable properties. The reasons were twofold. First, the dependent variable, which is to be defined later, contains zero values: the logarithm of zero is undefined. This problem with zeros can be overcome by adding a small constant to every observed value; yet there is no sound theoretical basis for this technique. Second,

and more important, the magnitude of the error propagated in the inputs when an additive model is used is generally less than that when a multiplicative model is used (see Reference 1). Hence, the generalized model is specified in the additive form:

$$(2) \quad V(i,j) = C(0) + C(1)X(1) + C(2)X(2) + \ldots \\ \ldots + (n)X(n) + U(i,j)$$

WHERE V(i,j) is defined as in Equation 1, X1, ..., X(n) are regressors which are combinations of the explanatory variables, and U(i,j) is an error term assumed to have zero mean and constant variance. The C0, ..., C(n) are regression coefficients to be estimated.

The Variable

The dependent variable for this study was the number of day-visiting parties traveling to a park during the 1969 season (May to October) from a given area of origin. The area surrounding each park to be studied was divided into a number of origin areas which are referred to as observation units. Each observation unit consits of a cluster of contiguous census subdivisions. The number of observation units for a particular park varies from 13 to 24. A total of 231 observation units were defined.

Based on the research findings cited earlier, it was felt that four basic explanatory variables would be adequate to explain the variance in the data being used in this study. It is well known that the number of day-visits made to a park varies directly as the size of population of an area of origin. The population for each observation unit i, P(i), is taken to be the total population residing in all the census subdivisions comprising the unit.

To examine the effect of accessibility on recreation opportunities, an impedance factor, denoted by D(i,j), was defined in terms of actual road miles from the largest population centre in observation unit i to the entrance of park j. Population centres that were more than 200 miles from the park under consideration were excluded, since an examination of the data revealed that day-visitors whose origins are more distant are insignificant in number. If there was more than one route available, the shortest route to the given park was used.

To reflect the competitive effect of alternate parks available to people residing in different observation units, a variable called the "alternative factor" was constructed for each of the 231 observation units. This factor was used to test the hypothesis that fewer visitors would be expected to go to a park at a given location from an origin that has many proximate alternate parks than from an origin with few close alternatives. The alternative factor used in this study reflects the existence of alternate parks within 100 actual road miles of an origin, since most of the main

destination day-visitors recorded in the survey traveled under 100 miles to a park.

In the construction of an alternative factor three elements are usually taken into account. These are the number of, the locations of, and some physical properties of the alternative sites. An alternative factor which has been used (see, for example, Reference 19) is of the form:

(3) A(i) = @E T(k)**a/D(i,k)**b

WHERE
A(i) = alternative factor for i,
T(k) = a variable reflecting some characteristics of the alternative site k,
D(i,k) = distance between i and alternative site k, and
a, b = constants, and the summation is over all alternative sites, k.

Since data on the characteristics of most of the alternative parks, which were largely local and regional parks, were lacking, T(k) was assumed constant. Different values of b were considered. In particular, b was tested at 1/2, 1, 3/2, and 2. The value of b finally selected was 1/2, since @E 1/D(i,k)**1/2 explained more variance of the dependent variable than the other three forms (see Table 1).

This resulted in the use of the following form:

(4) A(i) = @E 1/D(i,k) **1/2,

WHERE
i = 1, ..., 231,
j ≠ k = 1, ..., M where j refers to the park under consideration, and the summation is over k sites.

To measure site attraction, an "attractiveness factor" was derived. It is a function of the degree of popularity of a selected list of day-use activities and the quantity and quality of their associated recreation facilities. Its derivation assumes that the capacity of all parks is essentially infinite. (Park planners in Saskatchewan remarked that crowding did not appear to influence the day-users in most of the Saskatchewan parks). In deriving a numerical value of attractiveness for each of the twelve parks under consideration, two sets of CORD Study data were utilized. The first set of information was a 1969 survey in which approximately 3,000 individuals throughout Canada were interviewed. Information gathered included frequency of participation in 26 outdoor recreation activities, location of participation and reasons for nonparticipation. The second set of information was a set of inventory data which

TABLE 1

A COMPARISON OF THE EFFECTS OF THE DIFFERENT FORMS OF THE ALTERNATIVE FACTOR USED IN A REGRESSION EQUATION

ALTERNATIVE FACTOR*	REGRESSION COEFFICIENT	STANDARD ERROR	INCREASE IN R^2	F-LEVEL TO ENTER	OVERALL R^2**
$\Sigma_K 1/D_{iK}^{\frac{1}{2}}$	-36.60	3.12	0.06	143.79	0.91
$\Sigma_K 1/D_{iK}$	-102.48	11.27	0.04	85.35	0.89
$\Sigma_K 1/D_{iK}^{3/2}$	-157.20	26.15	0.02	36.38	0.87
$\Sigma_K 1/D_{iK}^{2}$	-198.13	47.59	0.01	17.56	0.86

* The alternative factor is multiplied by $P_i/g(D_{ij})$ as described in the text.

** This R^2 value is the value obtained using Equation (7).

contain site characteristic information such as the length of a bathing beach, number of showers, number of picnic tables, etc. (See CORD Study Data Documentation Volume.)

Table 2 presents the activities used in calculating the attractiveness factor, as well as the operational definitions of activities and the facilities for a given activity.

The attractiveness function is defined as:

(5) $T(j) = \partial E\ S(e)\ \partial E\ R(m)Q(m)$

WHERE $T(j)$ = attractiveness of park j,

and the other terms and sums are as defined in the following paragraphs.

TABLE 2

DEFINITIONS AND ASSOCIATED FACILITIES
FOR DAY-USE ACTIVITIES

ACTIVITY	DEFINITION	FACILITIES
Swimming	Swimming at a bathing beach	Bathing beach Water quality #of showers
Boating	Recreation use of boats with or without motors	#of boat ramps #of boat piers #of boats for rent
Horse riding	Riding for recreation	#of horses for rent
Hiking	Walking a natural trail	#of trails
Picnicking	Preparation and/or eating a meal outdoors	#of picnic tables Quality of shade
Golfing	Playing Golf	Golf Course

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As mentioned before, a 1969 household interview survey

provides a set of participation rates for 26 outdoor recreation activities which may be used to assess attractiveness. The participation rates relevant to the day-use activities considered in this study are presented in Table 3A. The term S(e), which is used to take into account the fact that not all outdoor recreation activities are equally popular, is defined as the participation rate X(e), of activity e, divided by the participation rate of hiking (the choice of the participation rate of hiking as a reference point is arbitrary). Thus defined, swimming is seen to be 1.10 times, while boating is only 0.79 times, as

TABLE 3A

POPULARITY RATINGS OF SOME DAY-USE ACTIVITIES

Activity	Saskatchewan Participation Rates X(e)%	Relative Popularity Rating S(e)=X(e)/29*
Swimming	32	1.10
Boating	23	0.79
Horse Riding	10	0.35
Hiking	29	1.00
Picnicking	69	2.39
Golfing	17	0.58

* The choice of 29 as reference for S(e) is arbitrary. S(e) = relative popularity rating of activity e and ƏE S(e) is summed over e.

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popular as hiking (see Tables 3A & 3B).

Accepting the scale as showing that not all outdoor recreation activities are equally popular leads to the consideration that not all outdoor recreation facilities are equally important in drawing attendance to a park. To evaluate the relative importance of the facilities, rank correlation coefficients between total day-use at the 12 parks considered in this study and each of the facilities listed in Table 2 were obtained using Spearman's rank correlation coefficient. The resultant coefficients are denoted by Y(m) in Table 3B. The relative importance rating R(m), for facility m, is obtained by dividing Y(m) by the rank correlation coefficient for a boat ramp. So, a bathing beach is assumed to be 1.88 times as important as a boat ramp, etc. (see Table 3A & 3B).

To account for the quantity or quality of the facilities, rank numerical values were assigned. The ranks, denoted by Q(m), range from 1 to 12. For instance, when the

TABLE 3B

IMPORTANCE RATINGS OF SOME DAY-USE FACILITIES

Activity	Associated Facility	Importance Rating of Facility Y(m)	Relative Importance Rating of Facility R(m)=Y(m)/0.31
Swimming	Bathing Beach	0.58	1.88
	Water Quality	0.16	0.52
	Showers	0.45	1.45
Boating	Boat ramp	0.31	1.00
	Boat pier	0.33	0.94
	Boat rental	0.19	0.61
Horse Riding	Horse rental	0.20	0.65
Hiking	Trails	0.11	0.36
Picnicking	Picnic tables	0.63	2.01
	Shade	0.18	0.58
Golfing	Golf course	0.41	1.32

NOTE:
* The choice of 0.31 as reference point for R(m) is arbitary.

R(m) = relative importance rating of facility m;

Q(m) = score of facility m, according to its quantity or quality.

and @E R(m)Q(m) is summed over m.

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number of picnic tables in each of the twelve parks considered in this study are ranked, and the quality of shade at the picnic grounds in these same parks are ranked, one obtains:

# picnic tables	rank value	quality of shade	rank value
38	1	P	1
58	2	F	3.5
81	3	F	3.5
100	4.5	F	3.5
100	4.5	F	3.5
105	6	G	9
107	7	G	9
140	8	G	9
147	9	G	9
148	10	G	9
163	11	G	9
270	12	G	9

WHERE: P denotes poor; F, fair; and G, good.

Hence, it may be seen that "100 picnic" tables received 4.5 points while "10 horses for rent" received 6 points and so on (see Table 4).

With the S(e), R(m), and Q(m) values calculated in the way discussed, it is possible to use Equation 5 to calculate various attractiveness values. The attractiveness values, T(j) of the twelve parks are listed in Table 5.

The Hypothesis To Be Tested

It was expected that population size, accessibility, alternative recreation opportunities, and attractiveness would interact to produce the observed differences on park use. To capture the interaction effects among the explanatory variables, four regressors were hypothesized to be necessary in an additive model. These were P(i)/g(D(i,j)), P(i)A(i)/g(D(i,j)), T(j)/g(D(i,j)), and 1/g(D(i,j)) where g(D(i,j)), which varies with D(i,j) is defined as follows:

$$(6) \qquad g(D(i,j)) = \begin{cases} D(i,j)/2 & \text{when } 0 < D(i,j) < 20, \\ D(i,j) & 20 \le D(i,j) < 55, \\ D(i,j)^{**}3/2 & 55 \le D(i,j) \end{cases}$$

TABLE 4

RANK SCORES* OF FACILITIES BASED ON GIVEN QUALITY OR QUANTITY

FACILITY	RANK VALUE, Q(m)
Bathing Beach	Fair - 4, Good - 9
Water Quality	Poor - 3.5, Fair - 5, Good - 9
# Showers	6 - 8, 8 - 10.5
# Boat Ramps	1 - 5, 2 - 8.5, 3 - 10, 5 - 11, 8 - 12, 1 - 7.5
# Boat Piers	1 - 7.5
# Rental Boats	8 - 7, 10 - 8, 14 - 9, 16 - 10, 30 - 11, 140 - 12
# Rental Horses	10 - 6, 12 - 7.5, 17 - 9, 22 - 10.5, 30 - 12
# Trails	1 - 6, 2 - 7.5, 4 - 9, 6 - 10, 12 - 11, 21 - 12
# Picnic Tables	38 - 1, 58 - 2, 81 - 3, 100 - 4.5, 105 - 6, 107 - 7, 140 - 8, 147 - 9, 148 - 10, 163 - 11, 270 - 12
Quality of Shade	Poor - 1, Fair - 3.5, Good - 9
Golf Course	9 Hole - 8.5, 18 Hole - 11

* The word before a dash refers to the quality of a facility, while the number before a dash refers to the quantity of the facility. The number after the dash is the score of the facility.

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TABLE 5

ATTRACTIVENESS RATINGS

Park	Attractiveness T(j)
Buffalo Pound	96.12
Cypress Hill	45.26
Duck Mountain	126.40
Echo Valley	112.05
Good Spirit	76.56
Green Water	61.46
Prince Albert	88.75
Moose Mountain	113.11
Pike Lake	96.10
Rowan's Ravine	59.01
Battleford's	104.28
Besant	26.60

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With the four regressors included, Equation 2 takes the following form:

(7) $V(i,j) = C0+(C1P(i)+C2P(i)A(i)+C3T(i)+C4)/g(D(i,j))$

WHERE

$V(i,j)$ = the dependent variable, which is the number of vehicles in hundreds estimated to be travelling to park j from observation unit i per season,

$P(i)$ = population, in thousands, of observation unit i,

$D(i,j)$ = road distance in miles, from the largest population center in observation unit i to park j,

$A(i)$ = alternative factor for observation unit i,

$T(j)$ = attractiveness of park j,

C0, ..., C4 = parameters to be estimated, and

$g(D(i,j))$ is defined by Equation 6.

The distance function $g(D(i,j))$ has also been replaced by continuous functions of the form: $(D(i,j)) = D(i,j)$ [c],

0 < D(i,j), where c = 1/2, 1, 3/2, 2, 5/2, and 3. Results showed that g(D(i,j)) gives a higher R^2 value than the other forms used (see Table 6).

TABLE 6

A COMPARISON OF THE EFFECTS OF THE DIFFERENT FORMS OF THE DISTANCE FUNCTION USED IN A REGRESSION EQUATION

Distance Function	Overall R^2*
D(i,j)**1/2	0.64
D(i,j)	0.84
D(i,j)**3/2	0.90
D(i,j)**2	0.90
D(i,j)**5/2	0.89
D(i,j)**3	0.87
g(D(i,j)	0.91

* This R^2 value is the value obtained using Equation 7.

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REGRESSION RESULTS

To estimate the parameters of the model described in Equation 7, stepwise multiple regression techiques was applied to data which consisted of the 231 observations (one for each observation unit). The equation obtained was as follows:

(8) $$V(i,j) = 1.33 + (120.31\ P(i) - 36.60\ P(i)A(i) + 1.25\ T(j) - 104.56)/g(D(i,j)).$$

The analysis of variance table for the regression is presented in Table 7. The coefficients, their standard errors, F-values, and the R^2 value at each step of the regression are presented in Table 8.

The equation determined is a reasonably good predictor since the overall F = 562.93 for regression is much more than 4 times the tabulated F = (4,266,0.999) = 4.62 with a 0.1 percent; as it is suggested it should be by Draper and Smith (see Reference 16). The term P(i)/g(D(i,j)) was the first to go into the equation and it explained a substantial amound (84%) of the variation of the dependent variable. Therefore, the equation should be very sensitive to a population or distance change. The term 1/g(D(i,j)) serves as a correction term of P(i)/g(D(i,j)) since some of the largest residuals were found observations which were at

TABLE 7

THE ANALYSIS OF VARIANCE FOR THE STEPS IN FITTING THE VISITATION EQUATION (EQUATION 8)

Step No.	Degree of Freedom: Regression	Degree of Freedom: Residual	Sum of Squares: Regression	Sum of Squares: Residual
1	1	229	120074.81	22594.67
2	2	228	128813.25	13856.22
3	3	227	129088.81	13580.66
4	4	226	129656.13	13013.34

Step No.	Mean Square: Regression	Mean Square: Residual	Overall F*
1	120074.81	98.67	1216.97
2	64406.63	60.77	1059.79
3	43029.60	59.83	719.24
4	32414.03	57.58	562.93

* These values are all significant at the 0.1 per cent probability level.

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short distances from a park. The term P(i)A(i)/g(D(i,j)) was the second to go into the equation and it explained six percent of the total variation of the dependent variable. Of all regressors, T(i)/g(D(i,j)) contributed least in increasing the R^2 value. Nevertheless, the precision of the estimate of the dependent variable was increased, even considering the loss of one degree of freedom. (It may be noted that the addition of a new regressor will generally increase the R^2 value (and never lower it) but it will not necessarily increase the precision of the estimate of the dependent variable, see Reference 16.)

In more practical terms it is important to reflect on the applied significance of the regression coefficients. It is interesting to note that the P(i)/g(D(i,j)) term, which first entered the equation and explained 84 percent of the variance, suggests an equation of the following form (when the constant term 1.33 is ignored):

$$V(i,j) = kP(i)/g(D(i,j)).$$

Given that this gravity model has explained so much of the variance, it is clear that it is an excellent first

TABLE 8

STATISTICS ON THE REGRESSION COEFFICIENTS OF THE VISITATION EQUATION*

Regression Coefficient	Value	Standard Error	F-Value	R^2
C0	1.33			
C1	120.31	5.80	429.80	0.8416
C2	-36.60	3.12	137.81	0.9029
C3	-104.56	27.30	14.63	0.9048
C4	1.25	0.40	9.85	0.9088

* All regression coefficients are significant at the one per cent probability level and all have the expected signs.

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approximation to the way people behave. This means that at best the pattern of alternatives and different site attractiveness can only explain some of the remaining 16 percent of the variance.

Both attractiveness and the alternative factor are introduced in a rather ad hoc way in this analysis. The kinds of arguments used suggest a change in participation would result from changes in an index reflecting a number of alternatives or in another index reflecting the quantity and quality of facilities. The fact, however, that the given indexes should be related to usage by Equation 8 rather than by some similar form has no sound theoretical basis. Yet, one can at least hope that a model which explains part of the 16 percent of the remaining variance after a "sample" gravity model is used will be a guide to a more "structurally" sound model leading to improvement in one's understanding of outdoor recreation phenomenon and thus to a better theory.

In particular, the fact that the regressor involving attractiveness goes into the equation with a low explanatory power leads one to suspect that the functional form of Equation 8 is incorrect in some respect or that the attractiveness measure itself is unsound. (See TN 9 and TN 28.) It is suspected that the problem has more to do with the error in the functional form than with the unsoundness of the attractiveness measure adopted. Still a computer run using V(i,j)/P(i) as the dependent variable and 1/g(D(i,j)), A(i)/g(D(i,j)), T(j)/g(D(i,j)) as regressors resulted in T(j)/g(D(i,j)) entering first into the equation and explaining 69 percent of the variance in the first step of the step-wise regression.

The coefficient of the alternative factor term is of more immediate practical interest than that of the attractiveness term. The value of A(i) for the various observation units in Saskatchewan ranges from 0 to 2.59 with an average of 1.48. One may regard the site for which there is no alternative as an "isolated site" and call the attendance figure of this site its "isolated site potential." Compared with isolated site potential, the average and maximum reduction in attendance due to alternatives, when other terms in Equation 8 are held constant, are thus (1.48 x 36.60/120.31) x 100% =54% and (2.59 x 36.60/120.31) x 100% = 79%, respectively. Of course, the model is meaningless beyond certain limits. If attractiveness is ignored, a negative number of visitors would result when A(i) is greater than 3.28. This limitation on the model strongly suggests that it will predict poorly for an origin having dense clusters of alternatives at short distances from the origin. Other than this, no undue difficulties will likely arise as a result of the alternative factor formulation when the model is applied.

APPLICATION OF THE MODEL

One of the main objectives of developing the day-use model was to predict the number of day-use visits to a park with a certain level of development. Because of the consideration of population size, accessibility, alternative recreation opportunities, and attractiveness it is reasonable to suggest that the model enables the planner to choose among alternative sites in deciding where a proposed park should be built (for an application, see TN 7). Intuitively, given certain assumptions regarding reaching a new usage equilibrium, the introduction of a new park will draw visitors away from existing parks and possibly induce new usage. On the other hand, the removal of an existing park from the system can be studied in a similar way. It is the pattern of change in use which results with a change in a system of parks that is of concern here.

To illustrate the planning use of the model, use estimates have been derived for a hypothetical park about thirty miles south of Rosetown in Saskatchewan. The location of the park, the observation units, and the corresponding population centres are shown in Figure 1. It is assumed that the facilities which the new park will contain are: a good beach with good water quality, eight showers, five boat ramps, one boat pier, 30 boats, 17 horses for rent, six trails, and 140 picnic tables with good shade. The characteristics of the observation units used for the calculations used to determine total use figures for the new site are listed in Table 9.

On the basis of the assumed characteristics and available census data, a total of 9,372 vehicles from the 15 observation units could be expected to come to the new park for a day-use visit during a given season. Attendance

Figure 1

Observation Areas of a Hypothetical Park

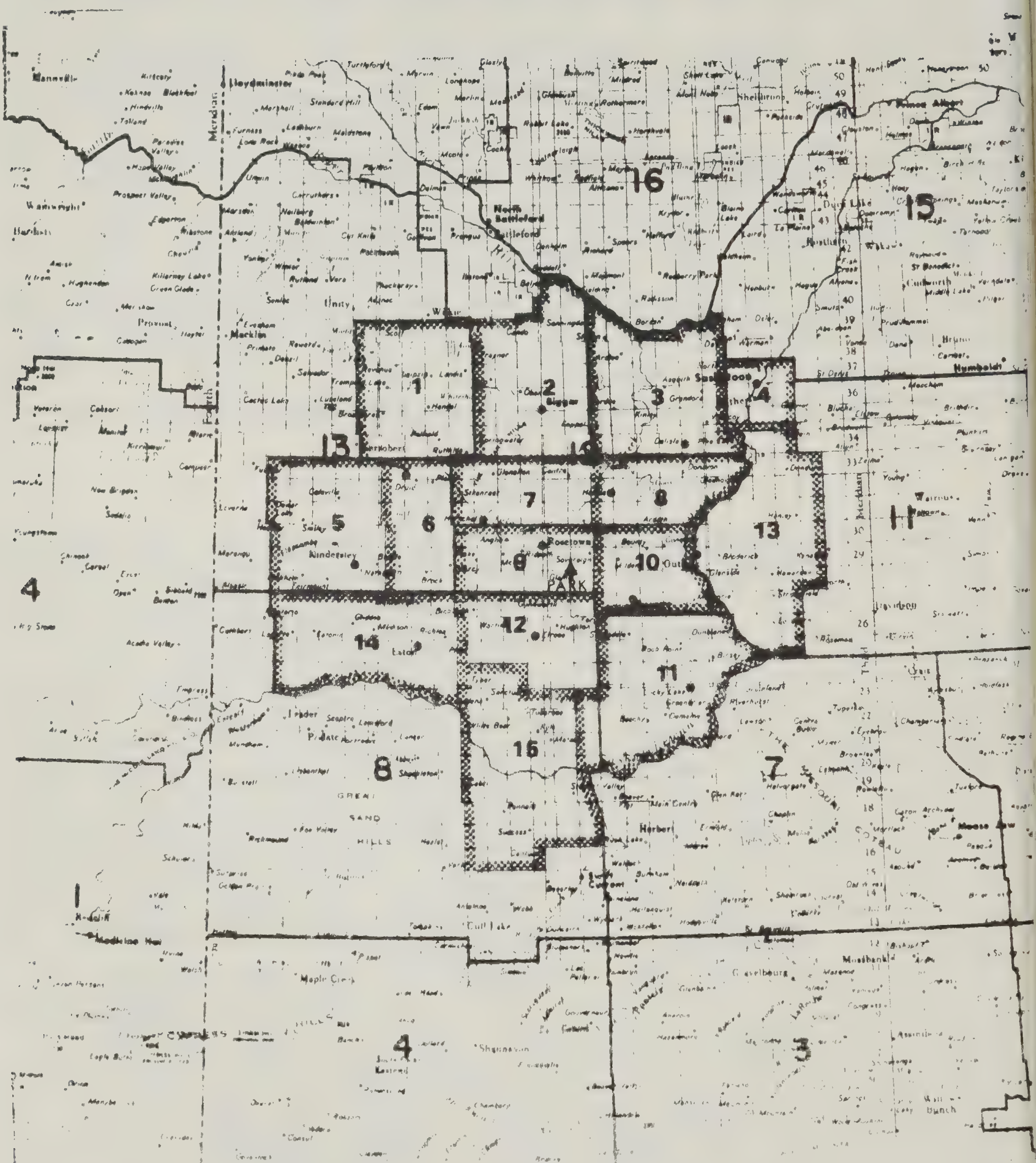

TABLE 9

PREDICTED MAIN-DESTINATION DAY-USE OF A HYPOTHETICAL PARK FROM OBSERVATION UNITS HAVING GIVEN CHARACTERISTICS*

Observation Unit	Population in Thousands, 1966	Population Center
1	3.96	Scott
2	5.53	Biggar
3	5.68	Delisle
4	117.41	Saskatoon
5	7.84	Kindersley
6	1.36	Dodsland
7	1.74	Herschel
8	1.63	Harris
9	4.18	Resetown
10	2.85	Dinsmore
11	3.81	Lucky Lake
12	1.78	Elrose
13	7.48	Outlook
14	5.18	Eston
15	4.98	Cabri
TOTAL	175.41	

Observation Unit	Distance, in Miles, From Population Center To the Park	Alternative Factor	Est. Vehc. (100's)
1	124	0.73	1.61
2	66	0.44	2.52
3	71	0.48	2.30
4	102	0.63	12.54
5	82	1.31	2.10
6	83	0.55	1.56
7	51	0.29	5.71
8	53	0.40	5.20
9	30	0.55	16.41
10	29	0.76	11.65
11	66	1.09	1.92
12	24	0.60	10.30
13	51	0.68	16.10
14	58	1.25	2.20
15	106	1.50	1.60
		TOTAL	93.72

* The attractiveness rating, by Equation 5, for the hypothetical park is 119.33.

figures from the various origins may be used for traffic consideration. Total use may of course be related to the demand on projected facilities, the need for staff, and the required budget for operation.

CONCLUSION

The model (Equation 8), developed in this paper, explains a reasonably large percentage (91%) of the diversity in the dependent variable, and the regression coefficients are all significant at the one percent probability level. So, the example of the application of the model to planning seems appropriate.

Improvements in the precision of the equation can perhaps be expected by using travelling time or a combination of travelling time and distance to formulate a new accessibility variable. Further research on attractiveness and the alternative factor to refine present methodologies and develop new methodologies for the measurement of these factors also seems appropriate (see TN 2, TN 3, TN 4, TN 9, and TN 28).

APPLICATION OF A MATHEMATICAL MODEL TO COMPARE THE USE OF TWO POTENTIAL PARK SITES

J. Beaman, H. K. Cheung, and S. Smith

ABSTRACT

Calculations of predicted visitor flows to a park depends (1)on being able to evaluate the probable attendance at the new park at a given time and (2)on being able to estimate the trends in attendance that are important in explaining changes in the predicted attendance and using these to estimate the attendance at the park at given future times. In this paper it is reported that past research resulted in the development of a mathematical model that was used to predict use of the two proposed parks being compared. Then available trend data were used to forecast use in the future based on the given season for which use had been estimated.

A special class of non-day users, main destination day users, was designated. The other class of user considered was campers who stay at least one night at a park. The importance of recognizing these classes of users to making estimates of the attendance at the two parks under the development options is stressed.

Also, policy considerations relevant to how the results of analysis are presented are introduced. It is pointed out that use figures predicted for the two parks are broken down by origin and type of users (day-use and camper) for a reason. This is so that managers responsible for selecting an option will know more than total use. The manager will know "who" is being served and how.

PURPOSE

The purpose of this Technical Note is to present the rationale for, and some of the details of the methodology used to predict, attendance at two potential park sites in Ontario, the Georgian Bay site and the French River Mouth site.

INTRODUCTION

That objective is not the original one. The note was originally prepared by Cheung and other CORD Study researchers to communicate a method of making estimates that was the best method these researchers could arrive at for making estimates in 1972, given their problem and the time

constraints under which they worked. There was a legitimate desire to make the work known to others so that should they find themselves in similar circumstances, they could utilize those of the ideas presented that they found relevant. However, since that original work was carried out, a number of research projects have resulted in good park use data (which is readily available) in a number of provinces and in the development of overnight use models that remove the need for making approximations of overnight use based on the amount of day use. As well, there have been other developments. Still, it is considered worthwhile to give some details about what was done and why, and to show what was not done because it was not possible with the data or the methodologies then available.

It is useful to recognize that an original objective of the project of calculating visitor flows to the two sites considered here was to evaluate their relative use as National Park sites. In general terms the points to be clarified by the modelling effort were (1) who could be expected to be served and (2) how. Given the data available when the study had to be done, the only variables which could be considered that would aid policy makers were types of users and origin of users. However, when the researchers started to seriously consider the information on types and origins of users, they found that a great deal of information could and should be developed. For example, the question of who is being served can be partially answered by giving a distribution of the origins of the future visitors to a site that will be developed. However, if users from one origin come primarily during daylight hours during the week and others from more distant origins come exclusively on the weekend for camping, this information should be given to planners and managers who are considering the site or comparing it to the merits of different sites. It would be inefficient to provide for weekday camping when the greatest demand occurs on weekends. On the other hand, weekday day-use facilities and programs might be provided at a very low cost (relative to camping facilities) but because of a proposed park's location these facilities might serve only one local community. Locating the park at another site might, with the same facilities, serve more communities.

In a similar vein, when one is not concerned with the origin of users, the presentation of one or two use figures that tell the whole use story to managers is an impossibility. In this paper, figures are given on the numbers of total visitors as well as figures on the number of total visitor-days. The "number of visitors" to a park is obviously not a precise measure, the only measure or even the best measure of the use of a park because, for example, visitors will stay for different lengths of time in a park and many visitors will visit a park several times on one trip while others visit it many times in one season. A park visit can last anywhere from a couple of hours to a week or more. Some measure of the mix of day-use and overnight-use and average length of stay is necessary for the planning of

services, programs, personnel needs and maintenance and for evaluating the potential regional economic impact of a park development.

Though results are not presented here, the distribution of use between weekdays and weekends is important. The possibility of developing predictive weekend and weekday-use models is discussed in TN 8 where an explicit methodology for defining loading curves for different types of park users by origin is specified. More theoretical statements of the need for a variety of different park use models by user types are presented in Technical Notes 30 and 40. In this present note the need to recognize the breakdown between weekend and weekday use was clear; however at the time of writing, carrying out the actual calculations was not possible.

THE MODEL

The basic model used in calculating the use figures for the two parks considered here was:

(1) $Y(i,j) = u + (C(0)T(j) - C(1)A(1,j))\ P(i)/g(D(i,j))$

WHERE

Y(i,j) = the dependent variable, the estimated number of main destination day-use visitors, in hundreds, travelling to park j from origin i per season;

u = a mean calculated in a regression;

T(j) = attractiveness of park j;

C(0), C(1) = scaling constants as determined by regression methods;

P(i) = population, in thousands, of origin i;

D(i,j) = road distance, in miles, from origin i to park j;

A(i,j) = alternative factor of origin i, with respect to park j, as defined in Cheung (1970) and where gD(i,j) has two alternative formulations A and B:

$$g(A)D(i,j) = \begin{cases} D(i,j)/2 & 0 < D(i,j) < 20 \\ D(i,j) & 20 \le D(i,j) < 55 \\ D(i,j)^{**}3/2 & 55 \le D(i,j) \end{cases}$$

OR

$g(B)D(i,j) = EXP(.0706D(i,j))$.

The A and B formulations account for the different results presented later.

Equation 1 is a modified form of the main destination day-use model developed by Cheung using CORD Study Park User Survey data for Saskatchewan (for details on the data see TN 1 and the CORD Study Data Collection and Documentation Volume).

The reasons that the Cheung model was not used per se in making predictions for the two Ontario sites were that (1) relevant park characteristics data such as that given in Table 1 for the construction of the attractiveness variable as defined by Cheung (TN 1) were not available, and (2) it was believed that attractiveness would have a multiplicative effect rather than an additive one on the volume of use. Cheung's original model, as is seen in Equation 1, suggested a basically additive effect. This suggested that a modified "Cheung model" of the following form be used:

$$(2) \quad Y(i,j) = (C(0)T(j)((1 - C(1)A(i,j))P(i))/g(D(i,j))$$

Assuming that Cheung's constant term u has an effect of less than 1% as it did in predicting use of parks in Saskatchewan, it can be ignored. And omitting the attractiveness term because it is considered that it should be a multiplicative factor as indicated in Equation 2 (T(j) is attractiveness), one can proceed to develop a new model. Assuming, further, that there are (on the average) four people in a vehicle that enters a park, one obtains, by some algebraic manipulations of Cheung's equation from TN 1:

$$(3) \quad Y(i,j) = 481.24\,(1 - 0.3\,A(i,j))P(i)/D(i,j)$$

Certain data are required before Equation 3 can be used to calculate visitor flows. Origin-destination figures were obtained from the Ontario Department of Lands and Forests. Since 1971 census figures were not available at the time that this research was carried out, 1971 population figures were estimated from census data by using the following equation:

$$(4) \quad P(1971) = (P(1966))^2/P(1961)$$

WHERE $P(y)$ = population in year y

This is obviously based on the assumption that the change in population between 1966 and 1971 would be the same as the increase between 1961 and 1966. It was recognized that this approximation was not very good but given other much more major inaccuracies, even using 1966 census figures would have been a minor source of error.

The preceding discussion has not been about a model that allows a park's total attendance to be estimated. It may already be clear to the reader that the model just introduced is one that is used only to calculate main destination day-use. The total estimated use at a proposed site consists of day-use (which is sub-divided into main

destination day-use and non-main destination day-use) and overnight-use. For the reasons indicated in the Introduction it is important to have estimates for these other classes of use. The problem facing the researcher or planner is, if one has only a day-use model and no time to develop other regression models, how does one obtain "scientific" estimates of the other types of use?

To this end it was necessary to use information on the ratio of main destination day-use to other uses. Camper registration figures for main destination Ontario provincial parks for the period 1968 - 1970 indicate that the ratio of day-use visits to overnight-use visits was approximately six to one (see Table 1). The number of overnight users, therefore, could be estimated once the number of day-users was known or estimated. The equations for the calculation of the total number of visitors and the total number of visitor days used were as follows:

(5) Total visitors = day visitors plus overnight visitors,

OR

(6) Total visitors = day visitors plus 1/6 (day visitors),

AND

(7) Total visitor days = (day visitors * 1) + (average length of overnight stay * estimated number of overnight visitors).

It was also recognized that there was a need to recognize the load that visitors place on a park by the differentials which are clearly noticeble in terms of an increasing average length of stay for campers from about 2.5 to 4 days from south to north. From Table 2 it may be noted that an average increase of 20 percent in camping stay occurred for Northern Ontario parks from 1968 - 1969. In the area being considered, it seemed reasonable to accept that a 10 percent per year increase in average length of stay for campers is to be expected as an average for all sites (see Table 2), at least for the next few years.

Now Equations 6 and 7 can be used for projection into the future if three rates are specified:

1. Per annum rate of increase of day-use = RIDV
2. Per annum rate of increase of overnight-use = RICV
3. Per annum rate of increase in average length of camper stay = RIALCS

The equations based on a continued constant percent growth for 5 to 10 years are :

(8) Total visitors (1971 + t) = (day-use) * (RIDV +1)**t * (overnight-use) * (RICV + 1)**t

TABLE 1

STATISTICS ON SOME ONTARIO "MAIN-DESTINATION" PARKS*

Name of Park	Acreage	Day-use Picnic Tables	Length of Day-use Beach	Day-use Parking Acreage
Oastier Lake	78	165	300 ft.	2.0
Arrowhead	1652	98	900	2.5
Sturgeon Bay	35	**	**	**
Killarney	84350	50	600	**
Grundy Lake	6313	552	800	8.0
Restoule	1635	**	**	**
Mikisew	420	90	1500	2.5
Killbear Point	4340	489	800	1.5

Name of Park	Number of Day-Use Parking Spaces	Number of Developed Campsites			Day-use/Campers		
		1968	1969	1970	1968	1969	1970
Oastier Lake	250	170	170	183	8.3	7.6	5.7
Arrowhead	210	102	253	253	3.8	4.6	4.7
Sturgeon Bay	**	87	89	87	5.6	3.6	8.7
Killarney	100	102	125	160	13.5	9.9	8.3
Grundy Lake	500	537	537	540	2.9	4.5	4.2
Restoule	**	229	229	225	2.7	3.6	4.7
Mikisew	226	256	256	256	2.2	5.4	5.3
Killbear Point	100	878	939	1018	4.6	6.6	5.1
	Average				5.5	5.7	5.8

* Being a main destination park refers to having over 50% main-destination visitors as reported by the province of Ontario.

** Unknown.

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(8) Total visitor days (1971 + t) = (day-use) * (RIDV +1)**t * (overnight-use) * (RICV + 1)**t * (RIALCS +1)**t

Data provided by the province of Ontario contained the necessary figures to calculate the needed rates. Data in Tables 2 and 3 show why RIDV = .069, RICV = .113 and

TABLE 2

AVERAGE LENGTH OF STAY - SUMMARY STATISTICS

Some Southern Ontario Provincial Parks	Average Length of Stay in Number of Days		
	1968	1969	1970
Holiday Beach	2.3	2.2	2.2
Ipperwash	4.4	4.9	5.0
Long Point	2.8	2.1	2.7
Pinery	3.1	2.3	2.2
Rock Point	1.6	1.4	1.6
Rondeau	2.4	3.0	2.2
Selkirk	2.0	1.7	2.0
Turkey Point	1.8	1.7	1.8
Wheatley	1.8	2.2	2.5
Craigleith	1.9	1.5	2.0
Inverhuron	2.4	2.8	3.7
Point Farms	2.1	2.4	2.4
Sauble Falls	2.3	1.7	2.3
Bass Lake	1.9	2.2	1.9
Devil's Glen	1.5	1.5	1.3
Earl Rowe	2.1	2.1	2.1
Mara	1.6	1.9	2.0
Sibbald Point	2.8	2.7	2.7
Six Mile Lake	1.9	1.7	2.0
Average	2.4	2.3	2.4

% Average Annual Change for South = 0.0%

Some Northern Ontario Provincial Parks	Average Length of Stay in Number of Days		
	1968	1969	1970
Arrowhead	1.7	2.2	2.5
Grundy Lake	2.0	3.0	3.0
Killbear Point	3.2	4.7	5.2
Mikisew	2.0	3.7	3.8
Oastler Lake	2.1	2.6	2.7
Restoule	2.5	4.2	4.5
Sturgeon Bay	2.0	3.2	3.3
Missinaibi Lake	-	3.7	3.8
Wakami Lake	-	5.1	5.3
Killarney	4.0	2.3	3.9
Windy Lake	3.1	1.8	3.0
Average	2.5	3.3	3.7
% Average Change (1968 - 1969)		32%	
% Average Change (1969 - 1970)		12%	

% Average Annual Change for North = 22%

"Over-all Annual Average" = RIALCS = (0.0 + .22)/2 = .11(11%)

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KIALCS=.11 were used.

However, given the equations that have been derived, a variety of figures may be calculated. Table 4(A & B) presents the predicted 1971 total visitors and total visitor days for Georgian Bay and French River Mouth. Formula A refers to use prediction obtained from the use of g(A)D(i,j) as defined for Equation 1. Formula B similarly refers to results obtained from g(B)D(i,j). The total use figures arrived at by summing up various columns in Table 4(A & B) provided a starting point for extrapolation to future use.

A constraint should be kept in mind on the procedure described here. The use of the rates cited to this point assumes that projections do not exceed the capacity of the site being considered. If capacity is not a factor, the application of Equations 8 and 9 result in the curves shown in Figure 1. Originally there were four parts to Figure 1. This was because it was deemed necessary to present results based on the use of both Formula A and Formula B (the different distance functions introduced earlier). In each figure, a manager or planner was able to see the load that will occur at the gate of a Park on the basis of number of visitors and also the load that will be on the Park in terms of day-use and number of camper days. The four curves were used to communicate different information that (in total) gives the planner and/or manager a better basis on which to formulate his views on how the Park should be designed and how it should operate. If only one of these curves were presented to managers, as indicated earlier, it would be impossible to recognize how a balance should be struck between developing day-use areas and developing campgrounds.

FIGURE 1

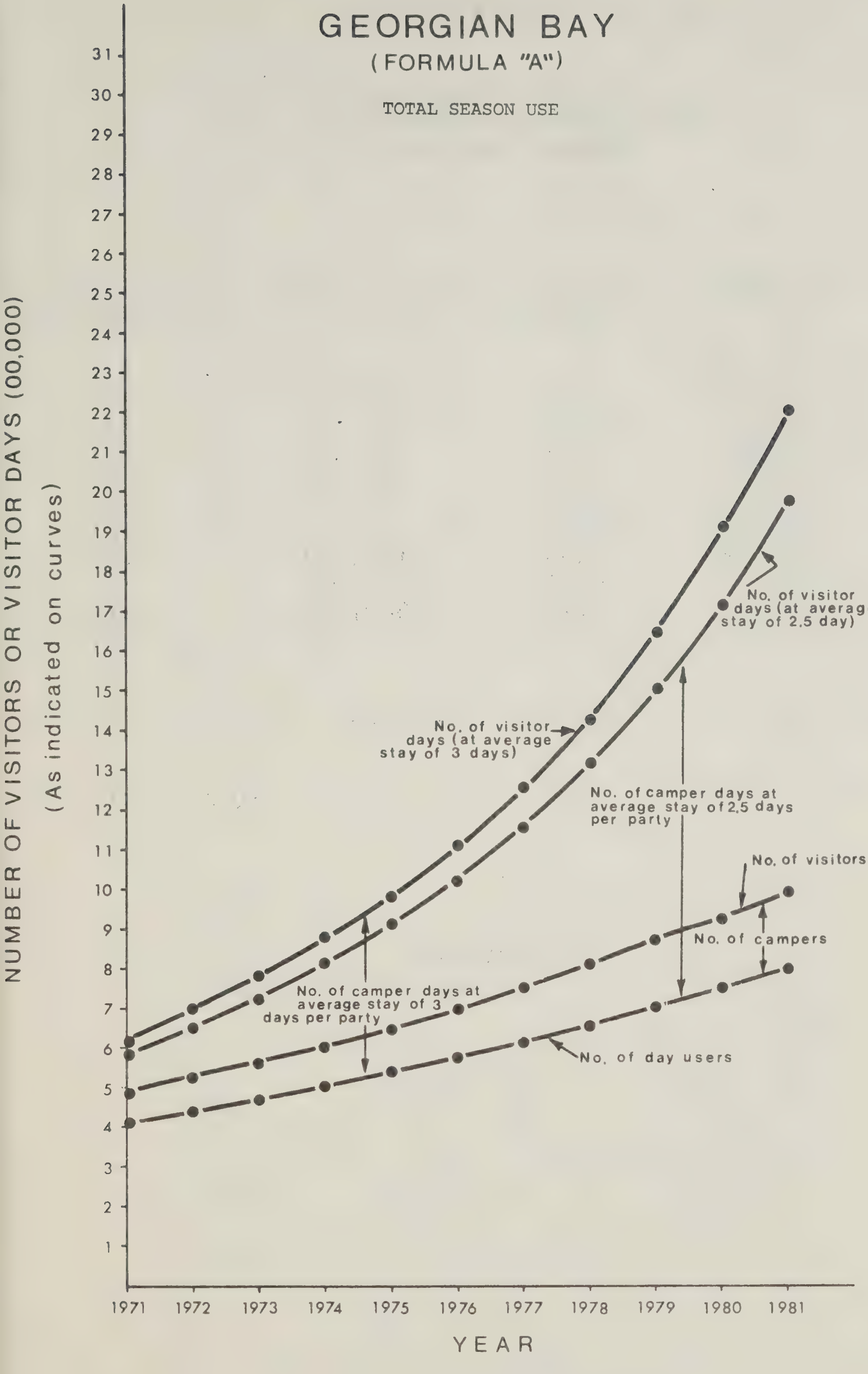
GEORGIAN BAY
(FORMULA "A")
TOTAL SEASON USE
NUMBER OF VISITORS OR VISITOR DAYS (00,000)
(As indicated on curves)
No. of visitor days (at average stay of 2.5 day)
No. of visitor days (at average stay of 3 days)
No. of camper days at average stay of 2.5 days per party
No. of visitors
No. of campers
No. of camper days at average stay of 3 days per party
No. of day users
YEAR
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981

TABLE 3

CHANGE IN DAY-USE
AND CHANGE IN CAMPER USE:
SUMMARY STATISTICS

Year	Total Season Day-Use	% Change in Day-use	Total Season Camper Use	% Change in Camp Use
1960	5,692,578		592,103	
1961	5,352,811	-6.0	862,559	45.
1962	6,757,867	26.2	1,063,127	23.
1963	7,685,952	13.7	840,491	-20.
1964	8,230,937	6.6	916,281	9.
1965	7,973,196	-3.1	902,472	-1.
1966	8,796,884	10.3	994,787	10.
1967	9,037,442	2.7	1,155,091	16.
1968	8,320,299	-7.9	1,119,912	-3.
1969	9,099,297	9.4	1,360,639	21.
1970	10,640,726	16.9	1,531,528	12.
	Average	6.9	Average	11.

RIDV = .069 RICU = .113

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TABLE 4(a): USE PREDICTION BY ORIGIN

	NUMBER OF MAIN DESTINATION DAY USERS				NUMBER OF NON-MAIN DESTINATION DAY USE				TOTAL NO. OF CAMPERS			
	VISITORS TO GEORGIAN BAY		VISITORS TO FRENCH RIVER		VISITORS TO GEORGIAN BAY		VISITORS TO FRENCH RIVER		VISITORS TO GEORGIAN BAY		VISITORS TO FRENCH RIVER	
	FORMULA A	FORMULA B	FORMULA A	FORMULA B	FORMULA A	FORMULA B	FORMULA A	FORMULA B	FORMULA A	FORMULA B	FORMULA A	FORMULA B
Niagara Falls	3,805	5,372					1,412	2,453	634	895	235	409
St. Catharines	6,805	8,980					2,177	4,016	1,090	1,497	363	673
Welland	2,624	3,803					1,078	1,761	437	634	180	294
Hamilton	22,912	26,604	6,320	11,426					3,819	4,434	1,053	1,904
Brantford	3,698	4,713					1,344	2,154	616	786	224	359
Guelph	2,290	3,274					977	1,527	382	546	163	255
Galt	2,728	3,040					1,039	1,402	455	507	173	234
Kitchener												
Waterloo	6,959	11,431					2,423	5,137	1,160	1,905	404	856
Woodstock					2,126	2,639	906	1,245	354	440	151	209
Stratford					1,910	2,510	854	1,189	318	418	142	193
London					6,742	11,871	2,404	5,334	1,124	1,979	401	889
St. Thomas					1,747	2,191	801	1,047	291	365	134	175
Sarnia					2,536	4,529	1,092	2,083	423	755	182	347
Chatham					1,981	3,081	897	1,441	331	514	150	240
Windsor					5,302	13,835	2,144	6,205	884	2,306	357	1,034
Owne Sound	2,286	2,387	940	1,097					381	398	151	183
Burlington	5,673	6,108	1,755	2,625					946	1,018	293	439
Oakville	13,553	14,212	3,585	5,584					2,259	2,369	598	931
Mississauga	9,406	9,877	2,487	3,538					1,568	1,646	415	590
Toronto	202,913	231,109	43,187	62,979					33,819	38,518	7,198	10,497
Detroit					21,186	67,189	7,946	29,839	3,531	11,198	1,324	4,973
TOTALS	327,494	369,759	206,521	200,250	82,114	201,693	44,652	111,732	68,271	95,245	41,865	52,001

TABLE 4(b): USE PROJECTION BY ORIGIN

	VISITORS TO GEORGIAN BAY AT AVERAGE STAY OF 3 DAYS		VISITORS TO FRENCH RIVER AT AVERAGE STAY OF 3 DAYS		VISITORS TO GEORGIAN BAY AT AVERAGE STAY OF 2.5 DAYS		VISITORS TO FRENCH RIVER AT AVERAGE STAY OF 4.5 DAYS	
	FORMULA A	FORMULA B	FORMULA A	FORMULA B	FORMULA A	FORMULA B	FORMULA A	FORMULA B
Niagara Falls	1,902	2,685	705	1,227	1,585	2,238	1,058	1,841
St. Catharines	3,270	4,491	1,089	2,019	2,725	3,743	1,634	3,029
Welland	1,311	1,902	540	882	1,093	1,585	810	1,323
Hamilton	11,457	13,302	3,159	5,712	9,548	11,085	4,739	8,568
Brantford	1,843	2,358	672	1,077	1,540	1,965	1,008	1,616
Guelph	1,146	1,638	489	765	955	1,365	734	1,148
Galt	1,365	1,521	519	702	1,138	1,268	779	1,053
Kitchener Waterloo	3,480	5,715	1,212	2,568	2,900	4,763	1,818	3,852
Woodstock	1,062	1,320	451	624	885	1,100	680	936
Stratford	954	1,254	426	594	795	1,045	639	891
London	3,372	5,937	1,203	2,667	2,810	4,948	1,805	4,001
St. Thomas	873	1,095	402	525	728	913	603	788
Sarnia	1,269	2,265	546	1,041	1,058	1,888	819	1,562
Chatham	993	1,542	450	720	828	1,285	675	1,080
Windsor	2,652	6,918	1,071	3,102	2,210	5,765	1,607	4,653
Owen Sound	1,143	1,194	453	549	953	995	680	824
Burlington	2,838	3,054	879	1,314	2,365	2,545	1,319	1,971
Oakville	6,777	7,107	1,794	2,793	5,648	5,923	2,691	4,190
Mississauga	4,704	4,938	1,245	1,770	3,920	4,115	1,868	2,655
Toronto	101,457	115,554	21,594	31,491	84,548	96,295	32,391	47,237
Detroit	10,593	33,594	3,972	14,919	8,828	27,995	5,958	22,379
TOTAL	204,813	285,735	125,595	156,003	170,689	238,119	188,405	234,015

DISCUSSION

Understanding what the modified Cheung model implies about attractiveness is important in evaluating whether the model proposed should or should not be used. To test whether the model did appear to be appropriate to the Ontario situation, use figures were generated for several Ontario Parks and these were compared with the use figures actually observed at these Parks. This gave a picture of whether the model is appropriate in terms of showing that the Parks in Ontario appear to follow roughly the model established based on Saskatchewan data.

One should note that the Ontario Parks that were considered and compared with the proposed Parks were not operating at capacity. When one examines Figure 1, one sees a drastic increase in the use of the proposed sites being predicted. Now, obviously the parks should not be opened with their 1981 capacity if they are to be opened in 1971 or 1972. Rather an approach should be taken that opens a certain amount of capacity to see if the use projections appear to be following the appropriate trajectory.

One point that cannot be stressed enough is that all of the estimates made in this article are subject to a great deal of error. Park planners and designers should not take the figures as gospel truth but take them as (at best) in a plus or minus 50% estimate. Given this fact an approach to planning called Discreet Incrementalism appears to be appropriate. Under this procedure a development plan is established but, at the same time, an evaluation program is set up in parallel so that the development plan can be modified if use estimates are not following the plan trajectory or if, in some other way, the park is not operating as it was planned that it would operate.

Certainly, when planning for a park is done based on the kind of computations illustrated in this note, it is critical to set up a use monitoring plan so that based on revised use estimates when the park actually opens, one sets up a scheme for managers and planners that will allow them to know if the park is having the use levels expected. If there were other objectives for the park (such as regional development etc.) information about the opening of enterprises, data on total sales etc. should be accumulated so that the goals for the park do not become lost in a procedure that sees an original intent handed over for implementation to people who may not know what that intent was and therefore may not be in a position to understand what is not happening that should be happening. This particular theme is taken up in more detail in CORD Study TN 40.

The capacity of sites presents special problems to modelling efforts. Examination of Ontario's data for Killbear and other sites (Table 6) suggests the guidelines given in Table 7. The figures in Table 7 assume a ratio of 6 to 1 day-use visitors to campers.

Table 7 provides guidelines that should be considered

TABLE 5: ATTRACTIVENESS DETERMINATION

CITY	FRENCH RIVER MOUTH BASED ON 0.6 ATTRACTIVENESS FACTOR AND 1.0 DISTANCE CORRECTION — Using GRUDY LAKE as a control site***		GEORGIAN BAY ISLANDS BASED ON A 1.0 ATTRACTIVENESS FACTOR AND $\frac{1.0}{(1-.31)}$ DISTANCE CORRECTION* — Using KILLBEAR as a control site***	
	FORMULA A	FORMULA B	FORMULA A	FORMULA B
Hamilton	1.6	1.0	2.6	2.3
London	2.1	1.1	4.5	2.9
Toronto	.9	.6	1.9	2.0
Sudbury**	1.2	1.6	1.2	1.1
St. Catharines	2.0	1.3	2.8	2.3
Kitchener - Waterloo	1.8	1.0	5.7	3.6
Oakville	1.3	1.0	2.8	2.9
Barrie	1.6	.47	1.1	1.9
AVERAGES	1.6	.92	3.1	2.6
	Average for the two formulas 1.25		Weighted averages = 2.5****	

*The distance correction is determined from $g(d) = e^{-.0706d}$ so that for 15 miles of extra travel $g(d_1)/g(d_2) = e^{-.0706(d_1 - d_2)}$

$$= e^{-.0706(15)}$$

$$= e^{-1.05}$$

**Sudbury figures are low because the alternative factor for Sudbury does not take into account U.S. areas or non-park areas that compete for use by Sudbury's population.

***The actual formula used in claculations used 1968 camper figures so camper visitation observed was compared to (camper visitation predicted) X (growth correction). The growth correction reduced visitation to about the level expected based on 1968 population by multiplying by a rate which is actually a $2\frac{1}{2}$ year correction. In terms of a formula:

$$\text{Attractiveness} = \frac{\text{No. observed campers}}{(1-r/2)}$$

$$r = \frac{\text{population 1966-popul. 1961}}{\frac{1}{2}\,(\text{popul. 1966 + popul. 1961})}$$

****Since Toronto is a major source of users a weighted average is used rather than (2.1 2.5)/2 [e.g. average j = $\sum_i$((users ij) (attractiveness j))/(users ij)]

TABLE 6

SOME FIGURES RELEVANT TO CAPACITY
([1]Per Season or Season Average)

Name of Park	July - August % Occupancy * No. Campsites[1]	1970 Number of Campers[1]	Ratio(1)[1]
Oastler	181	19,424	107.3
Arrowhead	124	14,279	115.2
Sturgeon Bay	84	7,682	91.5
Killarney	102	7,559	74.1
Grundy Lake	373	35,656	95.6
Restoule	108	6,620	61.3
Mikisew	136	10,166	74.8
Killbear Point	753	42,700	56.7

Name of Park	No. of Day-Use Picnic Tables	Number of Day-Users[1]	Ratio(2)[1]
Oastler	165	110,698	670.9
Arrowhead	98	67,644	690.2
Sturgeon Bay	**	67,109	
Killarney	50	62,762	1,255.2
Grundy Lake	552	150,564	272.8
Restoule	**	31,063	
Mikisew	90	54,371	604.1

$$(1) \quad \frac{(\text{Number of Campers})}{\%\ (\text{Occupancy})\ (\text{Number Campsites})}$$

$$(2) \quad \frac{(\text{Number of Day-Users})}{(\text{Number of Day-Use Picnic Tables})}$$

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reasonable capacity relations for use that tends to be at least 10% below design capacity. If a park runs at capacity, traffic considerations, crowding and other factor may affect use. It must be emphasized that the number of sites given in Table 7 should not be regarded as a design guideline. Care must be taken to ensure that "natural" and other biological balances are not upset by the creation of park facilities.

Given Killbear and other parks as providing back-up capacity for the proposed sites, one should expect to reach a balance between expected use and the capacity of the site by accepting the fact that biological and social

TABLE 7

CAPACITY CONSIDERATIONS

Total Season Visitation	#Campsites Assuming 4.5 Days Average Stay	#Campsites Assuming 3 Days Average Stay	#Day-Use "Sites"*
500,000	1,800	1,200	1,250
400,000	1,500	1,000	1,000
300,000	1,250	830	750
250,000	1,000	667	625
200,000	750	500	500
100,000	375	225	250

* The above assumes a ratio of 6/1 of day-user visitors to campers. The figures for day-use sites are not easily interpreted, but reflect "turn-over" and the fact that some day-users do not use "developed" sites or "double up".

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considerations should define a capacity which should not be exceeded. If use predictions exceed the design capacity, and if the park is to be a stable ecological entity, then use must be redistributed to conform to capacity.

CONCLUSION

This paper has traced the steps that have resulted in the estimation of various park use figures and suggestions that planners and policy makers have found useful. Data were supplied to planners to help ensure that the "best" answer to a planning problem that could be derived at the time was arrived at with full knowledge of the problems facing the researchers as they attempted to apply the model discussed in this paper.

It is primarily in the spirit of seeking reaction to their research philosophy presented that this paper was written. The greatest value that may come from it is that the critical and constructive reaction should be a response to what figures policy makers really need. It is certainly easy to attack the paper on the basis that (1) a Saskatchewan day-use model was applied to Ontario, (2) that adequate consideration was not given to the breakdown between weekend and weekday use, and (3) that proper consideration was not given to the effect of the "baby boom" and other demographic forces on the growth of park use in Ontario. To focus on these problems, however, is to miss the more important points and perspectives which are contained in this study. Planners, managers and policy makers often phrase questions regarding development options in casual imprecise forms that vary with each proposed development. More reliable, valid and useful data could be obtained if the data collection and analysis of various use-figures were standardized considering real needs. The authors believe that it is the responsibility of the researcher to comment on the practical significance of the numbers he arrives at and to guide policy makers and planners to ask for the right information: the researcher should not just react directly to requests but should also understand policy and planning well enough to guide planners and managers away from information they should not use, as well as guide them towards information that they should use (for reasons that follow logically from objectives).

CORD STUDY TECHNICAL NOTE 18

A METHOD FOR PREDICTING ENROUTE OVERNIGHT PARK USE

H.K. Cheung, S. Smith, J. Beaman

ABSTRACT

In this paper a regression model is presented for predicting overnight use at a park where campers are of the enroute type. These are campers who are enroute to somewhere other than where they stop.

In the multiplicative model developed, major arterial highways that are close to parks being studied were considered to be "sources of visitors". The level of traffic flow was used to define the "origin population". Two other explanatory variables were employed in the model – the number of campsites and the road distance between highway and park. In planning for a new park or changing an existing one these latter variables are suggested to be ones which, in selecting and developing a park, can be manipulated by a park planner to influence the amount of use a park will receive.

When the model parameters were estimated using linear regression (after a logarithmic transformation of the multiplicative model) all regression coefficients were found to be significant at the five percent probability level according to the F-test and all had the expected signs. The root mean square percentage error in predictions for individual sites obtained was 22.59 percent, indicating that, at least according to this measure, the fit was good.

PURPOSE

The purpose of this note is to report on research that has resulted from attempts to derive a predictive equation for enroute camping use in Northern Ontario. The equation derived is especially relevant to park planning because some of the explanatory variables used in its derivation are planning variables in the sense that a park planner may be able to manipulate them to influence the volume of use that a park receives.

INTRODUCTION

Generally speaking, park users can be classified into four basic types: (1) main destination day-users, (2) enroute day-users, (3) main destination overnight users and (4) enroute overnight users (for further elaboration of these classes see TN 8 and 30). An enroute overnight user, which is the one of concern here, is a camper who stays at a park for one night and then moves on.

The usefulness of disaggregating park users has been pointed out by Pankey and Johnston (see Reference 27). For

example, in a reservoir study they found that the root mean square (RMS) error of a linear equation for predicting total use (day and overnight) was 114. This was reduced when total use was broken up into day-use (RMS = 73) and overnight use (RMS = 80). They concluded that greater precision could be obtained when a researcher predicted day and overnight use separately and then summed them to obtain total use.

The point of pursuing the visitor classification issues raised above is that the model described in this paper (and applied herein to twenty provincial parks) is the outgrowth of one developed to forecast total use of Pukaskwa National Park. Pukaskwa is situated in a relatively isolated region in Northern Ontario (see Figure 1), about 192 road miles from Sault Ste. Marie and 220 miles from Thunder Bay. Each of these two distances includes a 12-mile link of paved road connecting the park to the Trans-Canada Highway. The park's location suggests that it would not generally be used as a main destination as is the case with many other Canadian parks. Indeed, an examination of the Ontario Camper Statistics (1971 Ontario Provincial Parks Statistical Report) revealed that most of the provincial parks in Northern Ontario had more enroute campers than main destination campers. Clearly, Pukaskwa's visitors would include many of those who travel the Trans-Canada Highway and who, while on their trip, would deviate, say 10 to 30 miles to the park as a convenient place to stop over.

By way of further introduction, the reader may wish to note briefly how the model presented here evolved. The original request by planners for assistance in developing a plan resulted in an early attempt to define a model. Planners were asked about their development ideas so that it would be possible to decide what types of users the researchers should consider. When it was recognized that the park would be established with the main stopping area approximately 25 miles from a major road, it became clear that it would be necessary to concentrate on enroute camping use estimates. It was not considered likely that people would merely drive into the main stopping area of the park to say they had seen the park when it would take them 50 miles out of their way. The researchers and planners also noted that there were no large population centres within 200 miles of the park. The primary source of visitors would be the traffic on the Trans-Canada Highway.

An important concern of the planners and park managers was the percentage of visitors who would be looking just for overnight accommodations as opposed to those who would be looking for a wilderness experience, which was the main purpose for establishing the park.

These users who (in terms of TN 23) made only partly desirable use of the park were important for two reasons: (1) the park has an important but secondary objective of regional development, and (2) it is these people for whom there was a need to plan because, in line with not preserving the park for a few hardy wilderness users, it becomes necessary to provide the space and facilities that

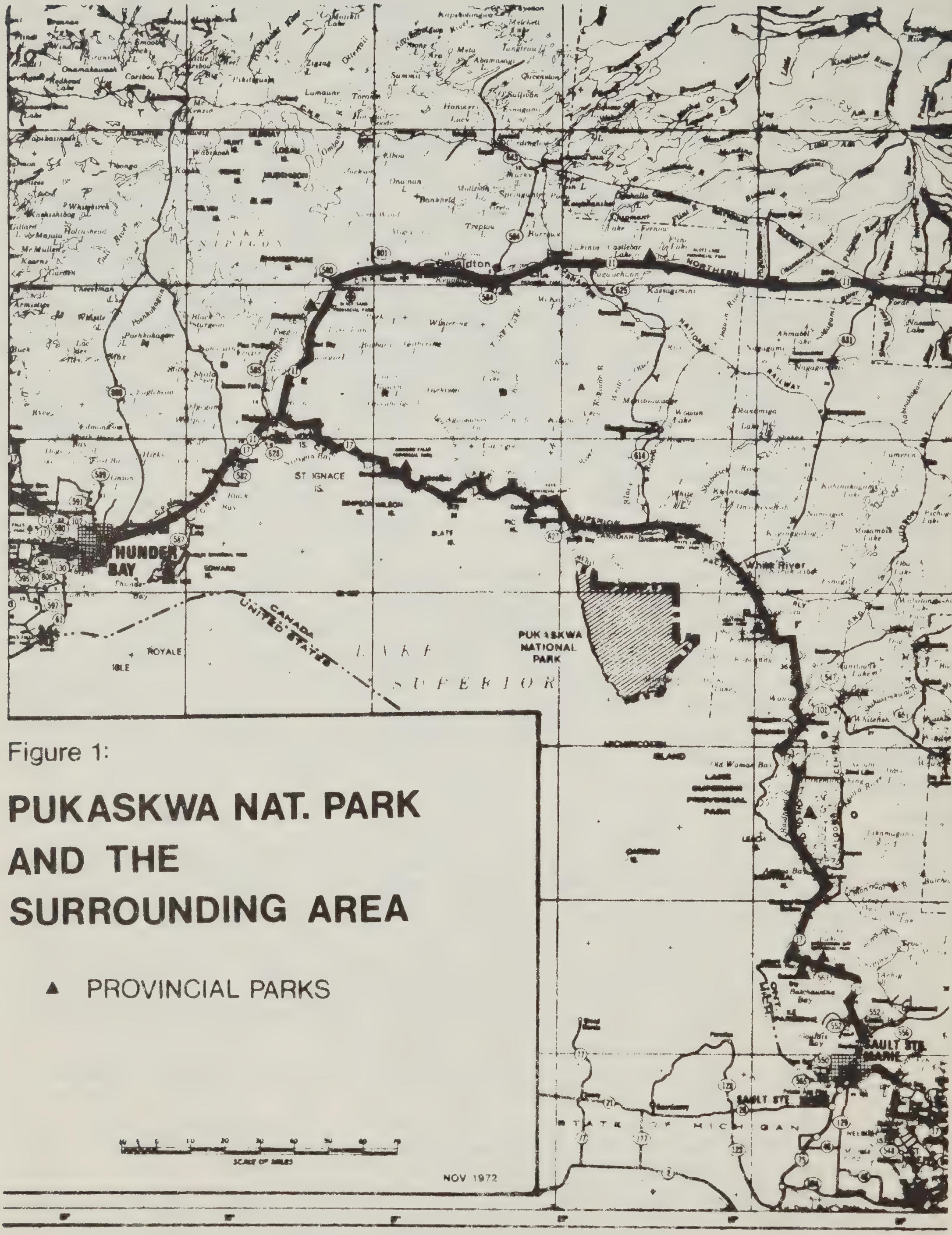

Figure 1:

PUKASKWA NAT. PARK AND THE SURROUNDING AREA

▲ PROVINCIAL PARKS

will encourage some enroute visitors to further investigate how they can make use of National Parks (the education and interpretation objective). There are some data available from other parks which are in similar situations, so it would have been possible to elaborate the model. However the researchers felt that it was adequate to pursue this issue of the number of interior wilderness use sites intuitively. The most important concern was to make sure that there would be sufficient capacity in the park so that the number of sites for the long-term visitors in the interior of the park could be expanded to meet demand as the use of the park increased. An initial capacity that seemed reasonably adequate to accommodate this type of user when the park was first open was already proposed in the parks draft master plan. So there seemed little merit in spending additional time and money to further define the need for wilderness sites.

THEORETICAL CONSIDERATIONS

Given a specific interest in developing an enroute camper model, a conceptual problem of model formulation is one of deciding the key variables affecting people's choice to stop over at a given park. A variable that is obviously important is the distance which people have to travel from their main route to reach the stopover park. How many people will deviate more than 15 miles from their main route if they do not intend to stop for any length of time at a given park but are, in fact, heading for some distant main destination? How many people will go even five miles out of their way on a gravel or poorly conditioned road? Clearly, both the distance and the condition of road should influence greatly one's decision to make an enroute visit to a park.

So it is reasonable to suggest that a major highway at a certain distance from a park serves as a generator of visitors in much the same way that a city at a given distance from a park serves as a generator of visitors (see TN 30 and Reference 28). The higher the weekday, weekend, (etc., depending on circumstances) annual average summer traffic volume, the more visitors one may expect to leave the highway and make an enroute visit to a given park. But there will be a certain volume of traffic that is commercial or business travel that will not stop at a park. Here it is assumed that the portion of potential park visitors in that flow of traffic is available from traffic partition counts. To avoid unnecessarily awkward descriptions of variables, one may refer to the traffic on a highway and mean it to be an estimate of the volume of the total traffic that is potential visitors.

Another variable considered to be important in influencing the decision to make an en route visit to a park is the number of campsites the park has. Almost certainly, the probability of people deviating from the main route of

their trip will depend on the probability of finding accommodation at the stopover park. It is reasonable to suggest that the chance that a site is available is higher at a park with a large number of campsites than at a park with a small number of campsites.

Cheung (see TN 1) has suggested that the facilities at a park influence its attractiveness, and that an attractiveness index based on the quantity and quality of the facilities could be used as a variable to predict park use. Both he and Beaman (TN 9) have suggested that the existence of other parks around a given park affects use either by modifying attractiveness or in some other way (see TN 11 and 33). One may consider the features at a park and alternative recreation opportunities as important variables affecting park attendance.

Given all of the preceding, enroute camping use of a park is hypothesized to be a function of highway traffic counts, the number of campsites of a park under study, and the road distance between this park and one or more highways. Variables such as road condition, park attractiveness and alternative parks were excluded in this analysis because of a lack of data. However these variables are not expected to affect the R^2 values substantially because (1) most of the parks studied have gravel roads connecting them to a major highway; (2) the specific concern in developing an enroute camper model was with an isolated site so alternative parks have negligible influence on park use; and (3) enroute campers perhaps have little concern for anything beyond having an acceptable campsite relatively easily accessible, with certain amenities such as drinking water and flush toilets. Regarding (3) the same basic amenities are provided in all the sites considered because they conform to Ontario Provincial Park Standards.

DATA

Data used in defining the dependent variable, the number of enroute campers visiting a park during a season, were drawn from the 1971 Ontario Camper Statistics (OCS) compiled by the Ontario Ministry of Natural Resources (see Reference 26). The OCS included information on type of campers, average party size, and length of stay. Since most of the parks selected for this study had more enroute use than main destination use, these numbers of campers were regarded, for practical purposes, as if they were all enroute campers.

Traffic count data used as the homolog of origin population were the annual average daily traffic (see Reference 24.) Information on the number of campsites in a park was obtained from the 1971 Ontario Camper Survey. Road distances between major highways and parks were obtained from an Ontario highway map.

METHOD

Twenty provincial parks in northern Ontario were used in the analysis. They are located near major arterial highways and provide similar facilities such as drinking water, flush toilets and fireplaces. Fifteen sites were actually used in developing the model; the remaining five were used for model validation.

The functional form of the model chosen for analysis of the use of the fifteen parks was:

$$(1)\quad V(j)=b(1)(T(j)^{**}b(2))\,(S(j)^{**}b(3))\,\exp(b(4)D(j))\,u(j)$$

WHERE

V(j) = the dependent variable, which is the observed number of "enroute" campers visiting park j during a season,

T(j) = annual average daily traffic count on a section of the arterial highway between two intersections leading to park j,

S(j) = the number of developed campsites in park j,

D(j) = the shortest road distance from the arterial highway to the entrance of park j,

u(j) = an error term, and

b(i) = parameters, i = 1, 4.

The multiplicative model defined by Equation 1 was changed into a linear one by using logarithmic transformation that allowed the use of linear regression analysis to estimate the parameters of the equation. The estimated equation was:

$$(2)\quad \ln(V(j))=3.22 + 0.37\ \ln T(j) + 0.80\ \ln S(j) - 0.03D(j)$$

RESULTS

The R^2 standard error of estimate and the F-value for Equation 2 are 0.89, 0.27, and 31.17 respectively. The equation derived is significant at the .01 level. The regression coefficients, their standard errors, and the increase in R^2 value at each step of the stepwise regression analysis are presented in Table 1. The coefficients of the model are significant at the five percent probability level according to the F-test, and all have the expected signs.

It is sometimes the case that the relative importance of the explanatory variables is suggested by the order in

TABLE 1

SUMMARY OF THE VARIABLES ENTERED INTO THE REGRESSION EQUATION BY STEP

Regr. Step	Variable	Regr. Coeff	Standard Error	R^2	Increase in R^2
1	Number of developed Campsites	0.80	0.14	0.70	0.70
2	Traffic Count on Arterial Highway	0.37	0.14	0.83	0.13
3	Distance from Arterial Highway to Park	-0.03	0.01	0.89	0.06

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which they enter in a stepwise regression. Also there is some merit in discussing the increase in the amount of variance in $\ln V(j)$ each explained when each new variable is added. From the convention perspective taken in interpreting stepwise regression results the number of developed campsites, a variable reflecting the capacity of a park, is the most influential variable of the three explanatory variables. The coefficient of the variable is 0.8, implying that a 10 percent increase in the number of campsites of a given park will result in an eight percent increase in use, ceteris paribus. Essentially, what the coefficient means is that attendance increases as the number of campsites increases, but at a decreasing rate (the problem with this interpretation is commented on subsequently).

The fact that the coefficient of the variable, "traffic counts" (0.37) is much less than unity may be taken to imply that use does not increase indefinitely as traffic volume increases.

The distance variable entered the equation last and explained six percent of the variation in the transformed dependent variable. The relatively small explanatory power of distance as a predictor variable in this model was expected because the average distance from an arterial highway to the entrance of one of the 15 parks used to develop the equation is only about four miles.

DISCUSSION

Measuring how well a regression explains data involves a number of complex issues (see TN 19 and 35) but certainly a measure such as % RMSE that gives an idea of the average percent error in estimates is a useful guide. Here the percent root mean square error (% RMSE) is defined as:

$$\%RMSE = [1/n\ @E\ (\%\ \text{error in prediction at park}(j)^2)]**1/2$$

WHERE

$$\%\ \text{error in prediction at park } j = \frac{(\text{Predicted Number of Campers at Park } j\ ) - (\text{Observed Number of Campers at Park } j\ )}{(\text{Observed Number of Campers at Park } j\ )} * 100$$

One may note that the percent root mean square error is also called the standard deviation of the percent error of prediction (see Reference 17.)

The 22.59 percent root mean square error (% RMSE) obtained indicates that the fit was relatively good. (On expected error and structural adequacy of models see TN 19 and 35.) The components of % RMSE, the percent error of prediction for the individual parks, varied from -5.54 to 36.63 (see Table 2). Some of these large errors may be caused by the absence of variables accounting for the effects of alternative parks and park attractiveness. In particular, the over-prediction of total season camping at Aaron may have stemmed from the failure to weigh the importance of the three competing parks lying close to it, namely, Sandbar Lake to the east, Blue Lake to the west, and Ojibway to the north. On the other hand, the underprediction for Neys and Sandbar may have arisen from ignoring the fact that the former is the only park among those studies that has boats for hire, and that the latter contains an excellent fishing area. The situation in the latter case is further complicated by the failure to recognize that not all enroute campers are the same in their preferences for a campground. Some may be strongly oriented towards some activity and thus perceive a different attractiveness for a park than those who are just looking for a place to sleep. A site with something "special" to offer can be expected to attract either some significant use as a main destination or use from activity-oriented enroute campers as well as use from the more ordinary enroute camper.

Thus far the model has been evaluated in terms of the plausibility and significance of the regression coefficients and the accuracy with which it can be used to make predictions for fifteen provincial parks. To further assess the predictive utility of the model, it was applied to the five parks that had originally been set aside for validation.

TABLE 2

OBSERVED AND PREDICTED VALUES AND PERCENT ERRORS
OF PREDICTION FOR THE PARKS USED
IN DERIVING THE VISITATION MODEL

Park	Observed 1971 Total Campers	Predicted 1971 Total Campers	Error (%)
Lake of the Woods	5,695	5,700	0.08
Invanhoe Lake	12,688	12,780	0.72
Pancake Bay	38,621	35,579	- 7.88
Obatanga	13,468	17,080	26.82
White Lake	25,316	27,853	10.02
Aaron	10,837	14,205	31.08
Greenwater	4,949	6,762	36.63
Klotz Lake	3,688	3,406	- 7.63
Blacksand	5,104	6,945	36.06
MacLeod	7,931	7,240	- 8.71
Neys	21,917	15,630	-28.68
Rainbow Falls	30,441	28,314	- 6.99
Sandbar	9,093	6,641	-26.96
Sioux Narrows	5,821	5,499	- 5.54
Inwood	18,072	11,310	-37.42

Root mean square error = 22.59%

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The results presented in Table 3 are further evidence that the model can be used for predicting levels of enroute use at predicted park sites.

CONCLUSIONS

The conceptual framework proposed here was found to be substantiated by empirical results. In fact, validation shows that the model developed should give accurate enough predictions for planning and policy purposes. So, the results of the analysis have shown that by varying the number of campsites in a park, or the distance between the park and a major highway, or both, a park planner can reasonably and consciously manipulate the amount of enroute use a park will receive. This paper provides specific guidelines as to what the consequences of such manipulations will be.

The use of the number of campsites as an explanatory variable is particularly useful when the carrying capacity

TABLE 3

OBSERVED AND PREDICTED VALUES AND PERCENT ERRORS OF PREDICTION FOR THE PARKS USED IN TESTING THE PREDICTIVE ABILITY OF THE VISITATION MODEL

Park	Observed 1971 Total Campers	Predicted 1971 Total Campers	Error (%)
Lake Superior	42,020	46,777	11.32
Wakami	4,183	3,872	- 7.43
Quetico	15,364	15,034	- 2.15
Kettle Lake	13,994	17,578	25.61
Nagagamisis	4,529	4,860	7.32

Root mean square error = 13.40%

of a park, in terms of camping use, is known. If one assumes that the "physical capacity" of a site is measured in terms of campsites that can be developed (for further discussion of carrying capacity in this context see TN 16 and Reference 22), one can use Equation 1 to determine the user-days of use to be expected to see if they can be developed without exceeding the social carrying or biological capacity of the site based on the level of management expenditure to be devoted to maintaining the site in a "sustained yield" condition (see TN 16).

Nevertheless, the use of the number of campsites as an explanatory variable in a regression equation causes concern for some outdoor recreation researchers. Their legitimate concern is related to what is called a "circularity problem". In essence, they argue that more campsites cause more use, which results in more campsites being developed (see Figure 6 in TN 40). It is impossible, they feel, to resolve this "chicken-egg" cycle in a way that justifies using the equation in the way described above. The author argues that correlations which when studied using regression analysis give the equation determined should not be read to imply a cause and effect relationship. It may be found that for established campgrounds there is an equilibrium condition reached which puts an end to "circularity": here because of the need to reach some conclusion the equation is treated as defining some kind of an equilibrium condition that "would eventually be reached", not as indicating anything about the dynamics of how the equilibrium would be reached.

Other independent studies have also shown the importance of the number of campsites on the attractiveness of parks. Cesario (TN 4) found that the number of campsites in a park was the major component of attractiveness. Should a researcher be concerned about using Cesario attractivities

because using them in some way implies that the number of campsites is used as an independent variable explaining camp use? Perhaps, but if the Cesario attractiveness do not seem to be useful for park use predictions what will be? The point is that there may be some problems with the model developed but, on the whole, there are many positive features. It is simple and requires relatively simple data to yield quite accurate estimates for other sites not used during the model's development. With appropriate projections of the highway traffic variable, and given accurate values of the other two variables, predictions can be made and there is good reason to think that they will be reasonably accurate. Clearly, the use of the model for prediction assumes that the parameters are accurately estimated and that they will not change appreciably during the prediction period and that the effects of alternative parks and park attractiveness have been correctly considered (see TN 37).

CORD STUDY TECHNICAL NOTE 30

A WORK PLAN FOR THE DEVELOPMENT OF A MATHEMATICAL MODEL TO PREDICT AND EXPLAIN OVERNIGHT USE OF PARKS

J. Beaman, S. Smith, and H.K. Cheung

(based upon work by
H.A. Macdonald, A.H. Netherton, and F.J. Cesario

ABSTRACT

This paper is about developing an overnight use model by using data collected in park visitor surveys. The mathematical models presented are ultimately meant to assist park planners to predict the number of visitors who will stay one night or more at new or modified parks.

In the report, which is based on a proposal for a study, such items in the original report as a list of tasks and a work plan flow chart are omitted. Only modelling considerations for actually developing overnight camping models are kept. As well, the material from the report "A Work Plan for the Development of a Mathematical Model to Predict and Explain Overnight Use of Parks", by MacDonald, Netherton and Cesario has been augmented by Smith and Beaman to focus attention on matters which they considered need more discussion since the purpose of the new report was not the same as that of the original report.

Incidentally, examination of the Saskatchewan CORD Study data and other potential data showed that these data were not good enough to merit the use of the kinds of models in the "Work Plan". This is the reason the "Work Plan" was never followed.

PURPOSE

The purpose of this paper is to present considerations for the development of an "overnight use" model to estimate park visitor flows. Data requirements and operational forms of the model will be discussed. The model developed will be developed in the specific context of camping.

INTRODUCTION

The first model developed by the Canadian Outdoor Recreation Demand Study was Cheung's main-destination day-use model (see TN 1). Cheung recognized that if a single equation was to be used to predict behaviour, that behaviour

had to be fairly homogeneous (see Reference 27). The model also had to apply to specific facility types offering the same recreation service. Initially a simple day-use, single destination model seemed to offer the greatest chance of modelling success. This was the form of Cheung's final model.

Much outdoor recreation behaviour, however, involves overnight stays; these activities (as opposed to day-use) tend to involve more travel and have greater environmental impact and economic ramifications. Thus it was desirable to researchers, planners and administrators that an overnight-use model be developed.

THEORETICAL CONSIDERATIONS

Overnight users of parks may be divided into several categories. Two of the more common classifications schemes include: (1) type of facility used (tent, trailer, pick-up camper, motor home, etc.) and (2) travel characteristics (e.g. weekend). This latter classification scheme - travel characteristics - is probably the more useful for park planning purposes. Frequently a park can handle a mix of camper vehicles and shelters without any significant maintenance adjustments. For planning purposes, the similarities between various campers grouped according to equipment styles are much greater than their differences. Important planning differences, however, do arise when one compares a transient camper, for example, with one staying at a site for a week.

This article suggests that, in general, campers can be divided into four rather diffuse groups:

(1) transient or enroute
(2) commuter
(3) destination
(4) quasi-second home

(For further comments on camper classification see Reference 4, 14, 21.)

Transient or Enroute Campers

This type of camper is on a relatively long trip and uses a campground on a single-night basis. His travel pattern is one of "hopping" from one campground to another. However, two different types of enroute campers can be identified. One considers enroute campsites as rest stops on a trip between his origin and some destination point or region. For example, a camper from Ontario heading for Banff National Park might consider stops on the Prairies primarily as rest stops. In this situation the Prairies would be viewed as an obstacle to be overcome as quickly as possible. Enroute stops would be chosen that were as close

as possible to the fastest route from his origin to his destination.

Alternatively, an enroute camper might consider certain areas in the Prairies as attractive sub-destinations and would be willing to take a more indirect route in order to pass through or stop at these areas. Different models would be required to predict the behaviour of these two types of enroute overnight campers. In the discussion that follows, only the former will receive attention, since he is probably the more common type of enroute camper and is certainly the easier to model. This type of enroute camper can be expected to look for a campground that is readily accessible to major through-routes and will accept minimal facility development (hook-ups for his equipment, a small store offering items such as flashlight batteries, postcards, aspirins, and a pool or small pond). Since enroute campers in a campground may be from any section of Canada or the United States, the "source of visitors" for modelling purposes is the adjacent highway(s), and not one particular centre of population. The relevant costs of enroute camping are the distance between the adjacent highway and the park and the charge for the overnight use of the campground. There are, of course, roadside campgrounds which cater exclusively to the transient or enroute camper. But many other parks, especially many provincial and state parks, also serve this function.

A model incorporating primarily traffic volume on major highways adjacent to these parks and the number of alternative parks should be adequate to estimate the number of visitors to a roadside park (see TN No. 18). In the more complex case (e.g. provincial parks), total overnight use estimates require inputs from two or three use-equations for the other camper types. (See TN 40, Figures 4, 5, and 6.)

Commuter Campers

The commuter camper utilizes a park near his home and place of work. Typically, the family will stay at a park for several days while the wage-earner commutes daily to his place of employment. The average length of stay for this type of park use is two to four nights. The commuter camper looks for a facility that, in addition to being close to his workplace, offers an attractive environment with some development such as swimming and fishing facilities. A "general store" is not always necessary, since the family can continue to follow its normal shopping patterns and replenish its supplies from home.

Destination Campers

Destination campers are probably the most diverse of the groups considered here. One individual may spend several days of his vacation as an enroute camper and then, upon

arrival in a major tourist area, become a "destination camper" for several days. When he returns home, he may become an enroute camper again. If the destination campground offers attractions such as a body of water, trails or beautiful scenery and a developed camp infrastructure (laundry, grocery store, other camper services) the camper might possibly stay a week or more.

Another type of destination camper may have no single destination point in mind. Instead he considers a region such as Nova Scotia and New Brunswick to be his destination, within which he plans a tour. In this case his overnight use of any one campground will be a function of not only attractiveness of that particular site but probably more importantly of the surrounding area and indeed of the whole region being toured. (See the comments on the meanings of attractiveness measures in TN 9 and on alternative-site functions in TN 3.) In other words, use of a particular park might depend more on regional characteristics than on the characteristics of the park. Thus a planning model for this kind of camper would have to predict the tour he chooses. And, as if this isn't difficult enough, in many cases the utility of a tour is not simply equal to the sum of the utilities of its parts. The latter situation might arise when a camper may wish a varied diet of activities and places to see. The result is that one activity (such as a day at the beach) may be more desirable (have greater utility) if it follows a day's river fishing than it would if the camper did nothing else but camped and lay on the beach. Because of these complications, the proposed model of overnight park use will be limited to destination campers with a single main destination, rather than a set of destinations with a variety of activities.

A second major distinction among destination campers is the duration of their stays away from home or work. The main effect of trip duration is likely to be that distance between home and destination plays a more important role as trip duration decreases. In other words, the length of the trip becomes increasingly critical as a camper has less time for the trip. No structural differences, however, are assumed necessary to adapt the models to different trip durations. But, without information on the break-down of total trip durations for each origin and each destination, it is difficult to predict the different trip durations. Calibrating a single model for all destination campers irrespective of trip duration is likely to produce predictions biased toward the mean or median trip length. In this regard Dice (see Reference 15) estimated that in Michigan 75 percent of campers camp on 25 percent of the days, primarily on weekends and public holidays. Such a high proportion of 2-day or 3-day trip durations suggests that it might not be too inappropriate, lacking more detailed data on trip duration, to perform only one calibration of an overnight destination model for Michigan using all overnight destination data.

Destination campers are confronted with travel costs

proportional to distance, road tolls, extra meals on the road, and park fees. Since distances are larger and play a more important role here than for enroute campers (who may have travelled just as far, but whose origin - for planning purposes - is the highway), income and other socio-economic data should be included in the destination camper travel model. Other factors to include are, of course, the quantity and quality of facilities at and around a destination, and a measure of the effect of competing alternatives.

Quasi-Second Home Campers

This last group of campers is a growing one, and one that is a fairly new phenomenon. The group is characterized by the storage of their camping equipment at a site, usually within a day's drive of home, for a season or for the year. They travel to the site for weekends and extended vacations throughout the year. Their strategy frees them (1) of having to load up their equipment every time they wish to make a trip, and (2) of the problem of where to store a motor home or camper. Since this group is still quite small, many parks do not permit year-round or seasonal storage, and their criteria for choosing a particular site may differ considerably from the other three groups. This group of campers is not considered in this study.

The above discussion has given profiles for different types of campers; the question can be raised as to whether there are different types of campgrounds. To an unknown extent, yes. Even someone not connected with the design, development or operation of a campground would suspect that the location and level of development of some facilities reflects the character of the user. For example, a campground located near a limited access highway interchange with few trees, a small pond, a small store and no other development (except for individual campsites) is designed to serve the enroute traveller. A campground in a remote park with excellent opportunity for backpacking, riding, fishing, hunting, swimming, and nature study plus a complete camper store can be expected to draw mostly destination campers. Many parks can thus be classified according to the same paradigm used for campers.

However, just as campers can exhibit a variety of behaviours on one trip or throughout a camping season, so, too, can campgrounds exhibit different characteristics. Large, well-developed parks located near highways or urban areas may attract a mix of destination, enroute and commuter campers. The immediate implication is that, for some parks, one type of travel model would not be adequate for projection purposes. It is necessary, of course, that the planner be able to accurately determine the character of the park - from an on-site visit, visitor records, design specifications and relative location. If this cannot be done, or if (1) a group of parks with different traveller characteristics or (2) one park with a variety of uses, is

being studied, then a more complex model with a series of equations relating to the different camper types is necessary. (See TN 40, Figures 4, 5 and 6.)

In the discussion that follows, destination and commuter campers are treated as one group and enroute campers as another. As will become clear below, it is felt that the criteria used by the two groups for choosing a campground are sufficiently different to necessitate two structurally different models to predict their choice behaviour. The same model can be used for destination and commuter campers because both are choosing a destination by similar criteria. However, different equations are developed for commuter and destination campers because it is assumed that the commuter camper puts more weight on distance than either the weekend or longer-duration destination camper. In other words, the difference in the importance of distance requires separate calibration of the same model for each group.

MODEL

Two sets of equations, one for enroute campers and one for main-destination campers will be derived. The problem of predicting visitor flow volumes is twofold. First, given the number of potential camper parties in any population centre, i, it is necessary to predict the actual number of camping parties, $N(i)$. Next, it is necessary to predict what proportion of parties from origin i, will make an overnight stop at park j. This proportion is $P(i,j)$

WHERE @E $P(i,j) = 1$ and the summation is over all i.

Given values for $N(i)$ and $P(i,j)$, the number of camper parties from origin i visiting park j in a given time period, is defined quite simply as:

$$(1) \qquad V(i,j) = N(i)P(i,j)$$

It is now necessary to obtain some methods for calculating $N(i)$ and $P(i,j)$. Since the enroute camper model involves only a small simplification of the main-destination model, the following discussion will concentrate on the main-destination model. Once the main-destination model has been derived, the equivalent enroute model will be formulated.

Participation Component

In the case of main-destination campers, participation is assumed to be a function of (1) the population and socio-economic characteristics of a population centre and (2) the accessibility attractiveness of camping facilities. Following the development in Cesario et al., (see Reference

16) a participation function for such park use is:

(2) $N(i)=kS(i)^{\alpha} P(i)^{\beta} (\Sigma A(j)/C(i,j)^{\gamma})^{\phi}$

WHERE

N(i) = the number of camper parties per time unit who go camping from centre i;

P(i) = the population of centre i;

S(i) = the average family income in centre i, used as a surrogate for the socio-economic characteristics of centre i;

A(j) = the "attractiveness" of park j;

C(i,j) = the cost of travel from origin i to park j, defined in terms of time or money;

m = the number of parks; and

$k, \alpha, \beta, \gamma, \phi$ = parameters to be estimated empirically.

and the summation is over all parks.

Equation (2) is option 1 of a participation component in the main-destination model. It states that if S(i) and P(i) are held constant, N(i) is a non-linear function of the sum of all parks' attractiveness/ accessibility ratios. (See TN 3 and 11 and Chapter I Review of this Volume for a further discussion of the role of such factors in destination-use models.) An alternative formulation of the participation component, option 2, is developed by considering the option as containing two elements:

(3) $N(i) = k\ S(i)^{\alpha} P(i)^{\beta} F(A(j), C(i,j))$

WHERE

F(A(j), C(i,j)) = the probability of a potential participant from i visiting any of the m parks at all in a given time period, where that probability is a function of the attractiveness (A(j)) and accessibility (C(j)) of all m parks; and the other terms are defined above

In the first element, the number of potential participants is some function of S(i) and P(i). The second element is the probability of a potential camper visiting any park per time unit. This is a function of the attractiveness and accessibility of all parks. Thus, unlike option 1, the probability of participation is explicitly considered and is defined in terms of the attractiveness and accessibility of all parks.

The probability term, $F(A(j), C(i,j))$, in Equation 3 is determined as follows. First, compute the probability of a camper deciding to visit no park at all. Represent this probability as: $G(A(j), C(i,j))$. If we can assume that $F(A(j), C(i,j))$ for each park is independent of the probability function of other parks, the rule of multiplication from conditional probability theory enables $G(A(j), C(i,j))$ to be defined as:

$$(4)\quad G(A(j),C(i,j)) = PI\ [1-F(A(j)-C(i,j))]$$

WHERE
$1 - F(A(j), C(i,j))$ = the probability of a camper from centre i deciding not to visit park j; and

m = number of parks.

and the probability is calculated over all parks.

Given that the probability of visiting any park at all is one minus the probability of not visiting any park at all:

$$(5)\quad F(A(j), C(i,j)) = 1 - G(A(j), C(i,j))$$

It follows from Equations 4 and 5 that Equation 3 can be rewritten as:

$$N(i) = k\ S(i)^{**\alpha}\ P(i)^{**\beta}\ [1 - PROD\ F(A(j),C(i,j))]$$

As developed in Cesario et al, let:

$$(6)\quad F(A(j), C(i,j)) = EL\ A(j)/C(i,j)^{**\gamma}$$

WHERE EL = the "elasticity" of the probability of a visit with respect to accessibility.

Therefore, Equation 5 can be rewritten as:

$$(7)\quad N(i)=k\ S(i)^{**\alpha}\ P(i)^{**\beta}\ [1-PROD\ (1-EL\ A(J)/C(i,j)^{**\gamma})]$$

WHERE the product is calculated over m parks.

This is Option 2 for a participation component of the main-destination model.

Distribution Component

When estimates of participation in camping are known for all the origins in the system, the trips are distributed to all the parks in the system. The attractiveness of, and the 'cost' of reaching, the parks in the system from the origins will determine the camping use that a particular park receives. Following the development in Cesario et al. (1969), the probabilistic distribution function for main-

destination campers, and enroute campers, is:

$$(8)\quad V(i,j)=N(i)\ (A(j)C(i,j)**\gamma /\ @E\ A(k)C(i,k)**\gamma)$$

WHERE
V(i, j) = the number of overnight camper parties that park j receives from origin i during a period of time; the other variables are as previously defined; and and the summation is over all parks.

The function is probabilistic in that

$$@E\ ((A(j)/C(i,j)**\gamma)/\ @E\ (A(k)/C(i,k)**\gamma))$$

for any one park, j, the expression defines the probability of a camper from centre i visiting park j.

Now incorporating the two options for the participation component, Equations 2 and 7, into the distribution function, Equation 8, gives the two alternative complete use models for main-destination campers:

$$(9)\quad V(i,j)=k\ S(i)**\alpha\ P(i)**\beta\ (\ @E\ A(k)/C(i,k)**\gamma)**\phi\ *\ \{(A(i,j)/C(i,j)**\gamma)/\ @E\ A(k)/C(i,k)\}$$

$$=k\ (S(i))**\alpha\ P(i)**\beta\ @E\ A(k)/C(i,k)**\gamma)**\phi-1\ *\ \{A(j)/C(i,j)**\gamma\}$$

WHERE the summations are over all parks. MODEL 1

$$(10)\quad V(i,k)=k\ S(i)**\alpha\ P(i)**\beta\ *\ \{1\ -\ PROD\ (1\ -\ EL\ A(j)/C(i,j)**\gamma\}$$

WHERE the summation is calculated over m parks. MODEL 2

For enroute campers, only one modification is made in Equations 9 and 10. Participation in this case is assumed to be a function of both the volume of camper vacation traffic and the overall attractiveness and accessibility of parks to the routes followed by that traffic. Unlike the main-destination model which uses origin socio-economic data to estimate its probable camper population, the camper population is defined in the enroute model as the volume of camper traffic on a particular highway. Therefore, the socio-economic variables used in Equations 9 and 10 are irrelevant in estimating the participation component of the enroute camper model. However, the term defining the overall attractiveness and accessibility of parks to routes used by camper vacation traffic is still relevant. Accordingly, the enroute model omits S(i) in Equations 9 and 10 and defines P(i) in these equations as the volume of camper vacation traffic on route segment i.

If it is assumed that all camper vacation traffic will make an overnight stop at one of the parks under study, then a simplified form of the enroute camper model can be used,

specifically:

(11) V(i,k)=k P(i) A(j) C(i,j)**γ/ @E A k C(i,k)**γ

As the total number of camper party visits has been estimated by the model as V(i,j), and number of nights per party is obtainable from on-site records of surveys, it is reasonable to consider these as two different phenomena. Camper party-nights is a figure representing the number of camper parties multiplied times the average number of nights per visit:

Total party nights = V(i,j) x average nights/party.

This simple calculation is meaningful for destination campgrounds at enroute campgrounds, although the average lenth of stay at an enroute campground will be close to 1.0.

DATA NEEDED

The following data are needed to operationalize Equations 8 and 10 for both main-destination and enroute campers:

1. The total number of parties from origin i visiting park j in a given time period.

2. The quantity (and qualities, if possible) of the facilities of park j.

3. The quantity (and qualities, if possible) of camping facilities of park j.

4a. The distance between origin i and park j. And/or

4b. The time required to travel the distance from origin i to park j. And/or

4c. The money cost of travelling the distance between origin i and park j, and the camping permit fee.

5a. The distance between park j and the nearest point on an arterial or major highway carrying vacation traffic. And/or

5b. The time required to travel the distance from the nearest point on an arterial highway to park j. And/or

5c. The money cost of travelling the distance from the nearest point on an arterial highway to park j, and the camping permit fee.

6. The average family income of origin i.

7. The population size of origin i.

8. The volume of camper vacation traffic on arterial highway segment i.

DISCUSSION AND CONCLUSION

As already mentioned in the section, Theoretical Considerations, the models defined in Equations 9 and 10 refer only to enroute campers who are 'making a bee-line' for a particular destination, and not to those who are willing to make a detour to one or more places of interest off their main route. Similarly, with main-destination campers, the models refer only to those campers for whom the attributes of a particular park (including its distance) are the sole criterion for choosing a particular camping destination. The latter restriction could be partially relaxed if attributes of the region in the immediate vicinity of the park were measured and used to define A(j). However, the models would still not cover those campers whose destination is a wider region within which several distinct destinations exist, since in that case the choice of one destination is not independent of the others chosen. To model such touring campers would require a structurally more complex model, as well as more detailed itinerary information.

As mentioned, it is clear that trip duration affects the choice of destination. Specifically, the more time a camper has, the greater the range of alternative destinations available to him. In terms of the models developed, the exponent on C(i,j) is expected to decrease as trip duration increases. However, it is also conceivable that the importance attached to different features of a park which influence its attractiveness will vary with trip duration. Thus, while back-packing facilities may be an important feature in a park for those contemplating a stay of three or more days, these facilities may assume much less importance than would, say, a campsite with a lake frontage for a weekend camper. While these variations do not necessitate any structural change in Equations 9 and 10, it is suggested that calibrating such equations using all camper visits irrespective of total trip duration might result in poorer predictive accuracy than if separate calibrations were performed. The latter, of course, would necessitate data disaggregated by trip duration.

Although the enroute model assumes that data on the volume of vacation traffic on highways adjacent to a particular park defines a user population and that the number of overnight stops at a park is a direct function of that volume, there is one instance in which this assumption may produce sizeable errors.

Let the word "origin" refer, for the moment, not necessarily just to home or work location but to the starting point for any day's journey. For example, for an enroute camper going from Ontario to Alberta, his origin on

a given day may be the park he stopped at the previous night. If, for the volume of vacation traffic measured on any highway segment i, the distribution of distances to origins is the same as for any other highway segment, then there is no problem in directly relating V(i,j) to that volume of vacation traffic. However, there are few obvious and important highway segments that will have distributions of distances from origins that are decidedly different from those of other highway segments. An example should help clarify this. On the highway segment immediately north of Toronto leading towards Sudbury and the west, a large percentage of camper vacationers heading towards Sudbury will have originated in Toronto. Thus, although the volume of vacation traffic may be vary high on that route, it is unlikely that many will make their first overnight stop within, say, 50 to 100 miles of Toronto, even if they left Toronto only late that afternoon. If on any highway segment a relatively large percentage of vacation travellers comes from a nearby origin, the proportion making an overnight enroute stop at a park in the vicinity of that highway will be less than would normally be predicted from that volume of traffic. Clearly, this problem will be most acute in the vicinity of metropolitan areas. The point is that the simple volume count of vacation traffic on a highway segment is likely to be a much poorer predictar of the number of enroute stops at an ajacent park then the use of frequency distirbution of distances to those travellers' origins for the day.

A final problem that can be noted is that both Equations 9 and 10 are non-linear functions with, respectively, four and three parameters to be solved for, if the values of park attractiveness are assumed to be defined exogenously. If A(j) values are to be estimated within the model then Equations 9 and 10 have m ± 4 and m ± 3 unknown parameters. It is not certain that any reliable and efficient solution technique exists. Particularly with m ± 4 and m ± 3 unknowns, a heuristic non-linear regression algorithm is unlikely to converge on a solution in any reasonable time. However, it is more likely that with three or four unknowns, a non-linear regression procedure could be used effectively, although even in this case optimality is not assured and required computer time may be large.

In conclusion, the proposed models of enroute and main-destination overnight park use have been argued to be applicable to a certain well-defined type of main-destination park user and a certain type of enroute park user. Insofar as there are many minor variations in camper types, it may be reasonable to consider developing a more general model which could subsume the types considered in this paper as special cases. In the process of deriving such a model, care should be taken to see that it is mathematically soluble.

ESTIMATING PARK ATTRACTIVENESS, POPULATION CENTER EMISSIVENESS, AND THE EFFECT OF DISTANCE (LOCATION) IN OUTDOOR RECREATION TRAVEL

F. J. Cesario

ABSTRACT

This report contains a discussion of the results of the application of a two-stage methodology for estimating certain parameters of outdoor recreation travel. Stage I analysis results in extracting systematic travel (distance), population center (emissiveness) and park effects (attractiveness), from outdoor recreation trip-making data by the use of an analysis of covariance technique. A "reaction to travel parameter" is also determined. Stage II analysis is where the researcher attempts to account for differences in estimated population center (emissiveness) and park (attractiveness) effects by of mUltivariate analyses. The goal at this stage is to identify those population center characteristics (population, mangitudes, income, age, etc.) that appear to best account for observed variations in aggregate outdoor-recreation trip-making behaviour and to identify park characteristics, etc. that account for attractivity.

Stage I analysis of Ontario data obtained from camping permits showed that statistically significant population center, park and location effects on camper trip-making could be extracted from the 1968 Ontario data on all use of Ontario campgrounds.

Stage II analysis had some expected consequences and some unexpected consequences. Emissiveness (city effects) were found to be explained by city size with income not being important. It is well known that the volume of visitor flow from an origin to a destination is proportional to the population of the origin, but income is usually also considered to influence the volume of flows. For attractiveness, it was found that such expected factors as size of park and numbers of campsites had a positive influence on park attractiveness. But, the complexity of the relation discovered has not been recognized in the past.

The ways in which the results can be put to practical use by planners and researchers are emphasized.

INTRODUCTION

In the planning and design of park systems, outdoor recreation agencies are continually faced with a series of

complex questions. How many parks are needed? Where should new parks be located? What existing parks should be expanded and in what ways? What mix of what activities should be provided on what sites? How many camping spaces should be provided? The list of such planning questions is virtually endless. Since recreation budgets are not unlimited, hard choices must be made in deciding exactly what levels and mixes of recreation opportunities to provide and where to provide them.

It can be realistically argued that rational planning would involve a systematic exploration of alternative plans and policies in a formal or systematic way: that is, an "informed" choice would take into account all (or as many as possible) of the consequences of alternative solutions to a particular planning problem before deciding upon a specific course of action. In many cases, the park use implications of alternative plans and policies are of paramount importance. For example, a recreation agency might wish to choose that alternative which promised to result in the greatest increase in regional recreation visits (properly distributed). But then it is imperative that the planning agencies have on hand considerable relevant information with which to assess the visitor implications of each financially feasible plan of recreational development that may be considered when resources are to allocated.

In an attempt to develop this relevant planning information, the last ten years or so have seen many outdoor recreation researchers working on the construction of "models" which purport to "explain" or "predict" various aspects of outdoor recreation trip-making behavior (see References 6, 17, 19, 27, 35.) These models attempt to relate various measures of park use to the factors that give rise to them. They have, in fact, provided many insights as to what factors are and are not important.

Yet, these modeling efforts have been plagued by some common difficulties. The modeler is inevitably faced with the complex problems of, first, selecting the appropriate variables to include in his model and, second, postulating how these variables might combine to give rise to a particular use pattern. In short, there are major unresolved problems concerning both the substance and the form of the relationships. In many cases the variables are arbitrarily chosen - perhaps on the basis of data availability - and the model is constructed within a linear framework because that class of model is easily soluble. But it is a rather restrictive approach. It may be possible to do better. Such improvement is a goal of this study.

This report contains the results of a pilot study carried out in Ontario, using a new and untested methodology developed by the author, to identify those factors which by themselves and in combination appear to be the most important influences shaping park use levels and related patterns in outdoor recreation systems. As will be seen, this new methodology represents a substantial departure from previous methodologies and, with appropriate qualifications,

offers considerable promise of (1) allowing better prediction of visitor flows than has been possible, and (2) affording insights into the particular factors that are important in determining these flows. Utilizing findings obtained in this study and possible future applications of the research methodology, outdoor recreation planners and researchers will hopefully be able to make improved decisions in their respective areas of responsibility.

FRAMEWORK FOR ANALYSIS

The purpose of this investigation is to test, on a pilot study basis, a research methodology to identify factors that appear to be important determinants of park use and to uncover the particular (aggregate) characteristics of specific parks and of specific population centers which give rise to observed variations in regional outdoor recreation tripmaking behavior. In addition to revealing these population center and park effects, the effect of distance (i.e., location) on participation is isolated.

For analysis purposes, assume that the region of interest (e.g., part of a province, an entire province, several provinces) is subdivided into N mutually exclusive population centers (e.g., counties, townships, census tracts). Assume that there are M outdoor recreation parks located in, and possibly out of, the region. The distance between population center i and park j, as measured (say) by the number of road miles over the route of minimum distance, is denoted by d(i,j). Let (d(i,j)) be an (NxM) matrix of trip distances. Let v(i,j) represent the number of visits of a particular type observed to emanate from population center i and terminate at park j during some time period of finite duration. Then (v(i,j)) is an (NxM) matrix of trip frequencies.

Let the total number of recreation trips emanating from population center i be denoted by O(i); let the total number of trips terminating at park j be denoted by V(j); and let the total number of trips taken in the region be denoted by W. Then:

(1) O(i) = @E v(i,j) ; i=1,2, ... ,N

WHERE the summation is over M parks.

(2) V(j) = @E v(i,j) ; j = 1,2, ...,M

WHERE the summation is over N population centers.

(3) W = @E O(i) = @E V(j) = @E @E v(i,j)

WHERE: the i's are summed over N population centers;
and the j's are summed over M parks.

From the above, it is seen that V(j) is merely the total

TABLE 1

TRIP DISTRIBUTION TABLEAU

j	Parks				@E v(i,j)
i	1	2	...	M	
1	v11	v12	...	v1M	01
2	v21	v22	...	v2M	02
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
N	vN1	vN2	...	vNM	ON
@E v(i,j)	V1	V2	...	VM	W = @E O(i) = @E V(j)

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visitor flow from the region observed at park j during the relevant time period. The above quantities of interest are displayed in the tableau of Table 1. This analysis assumes that trip-making data of the above type are available for at least one time period (e.g., a summer season). Further, it is assumed that it is possible to measure certain overall socio-economic characteristics of the population centers as well as specific site characteristics of the parks under consideration. In this context, we then ask what it is possible to learn from these data.

METHODOLOGY

The methodology employed in this study is a two-stage estimation procedure. The first stage of the anlaysis extracts systematic population center and park effects from the data structured as in Table 1. The second stage attempts to identify the population center and park characteristics that appear to account for differences in these effects. Before discussing each stage of the analysis in detail, it is useful to present a brief overview of the underlying modeling postulates.

Theoretical Basis

Basically, it is postulated that the number of recreation trips made from population center i to park j is a function of (1) certain population center characteristics such as population, size, income distribution and measures of other socio-economic factors, (2) certain park

characteristics such as acreage, miles of shoreline and other natural or man-made features, and (3) spatial separation. Further, it is assumed that population center characteristics relate to each other in a certain way. Similar assumptions can be made with respect to park characteristics and spatial separation. Thus the number of visits from population center i to park j may be expressed as:

(4) $V(i,j) = f(g1(\text{population center characteristics}),$
$g2(\text{park characteristics}), h(d(i,j)))$.

It is assumed that g1 and g2 are independent of h(d(i,j)) and that their particular functional forms are unknown. The functional form of h(d(i,j)) is presumed to be specified except for values of its unknown parameters. Viewed in this way the estimation problem is one of finding appropriate functions g1 and g2 as well as any unknown parameters of the particular distance function h(d(i,j)) employed.

In a lengthy development, Cesario (see Reference 8) made the above concepts operational by formulating the following model structure:

(5) $V(i,j) = KE(i)A(j)h(D(i,j))\exp(@e(i,j))$

to be representative of the data, where K is a constant of proportionality; E(i) is an unobservable population center factor calleα "emissiveness"; A(j) is an unobservable park factor called "attractiveness"; h(d(i,j)) is a particular distance function; and $\hat{e}(i,j)$ is an error term. The quantities v(i,j) and d(i,j) are observable whereas E(i), A(j) and parameters of h(d(i,j)) are unobservable and must be estimated. Cesario (see Reference 7, 8) indicates vectors (E(i)) and (A(j)) are each specified up to multiplicative constants (i.e. only ratios $E(i)/E(k)$, $k \neq i$ and $A(j)/A(\ell)$, $\ell \neq j$ have meaning).

Thus, emissiveness of population center i, E(i), reflects its relative propensity (to other population centers) to emit trips under identical circumstances - (that is, as if all centers were confronted by the same availability or "supply" of recreation opportunities). Emissiveness thus serves as a relative measure of population center "participation" that is unencumbered by the existence of a differential supply factor. It is seen to be a metric that represents the combined effects of a multitude of population center characteristics on recreation trip-making. It is possible, of course, to think of many reasons why one origin might be more emissive than another. One obvious reason is due to the possible differences in population sizes among population centers. Another reason might be due to differences in socio-economic composition of the population. Each of these factors needs to be investigated to discover the role each plays in giving rise to differential E(i) values (to estimate g1).

In contradistinction to emissiveness, attractiveness of park j, A(j), reflects its relative ability (to other parks) to attract trips under identical circumstances (for example, as if all parks were equally accessible from each population center). Attractiveness thus serves as a measure of park "popularity". It is a metric that reflects the combined effects of a multitude of park characteristics on recreation trip-making. There are many potential reasons why one park might be more appealing than another: one might have excellent swimming facilities whereas another does not; another might have an excellent network of hiking trails, whereas another has none. Again there is a need to account for differential A(j) values in terms of these factors (to estimate g2).

Finally, the distance function h(d(i,j)) is a "correction" term to account for violations of the above ceteris paribus conditions. Various functional forms can be used. Common examples are $h(d(i,j)) = d(i,j)[\beta]$, $h(d(i,j)) = \exp(\beta d(i,j))$, and $h(d(i,j)) = d(i,j)[\beta] \exp(\alpha d(i,j))$ where α and β are parameters to be estimated. Each of these functions has different behavioral implications (see Reference 14).

From the above, we see that the process of extracting relevant factors affecting park use may be thought of in two stages. Stage I would involve the estimation of vectors $(\hat{E}(i))$ and $(\hat{A}(j))$ of Equation 5. Stage II would determine the combinations of population center characteristics and park characteristics that appear to account for whatever differences were found to exist in the $\hat{E}(i)$'s and $\hat{A}(j)$'s. This is the essence of the methodology under the test.

Stage I: Estimation of Vectors $(\hat{E}(i))$ and $(\hat{A}(j))$

A logarithmic transformation of Equation 5 for a particular h results in what is essentially an analysis of covariance model from which estimates $(\hat{E}(i))$ and $(\hat{A}(j))$ can be ultimately obtained. Letting $h(d(i,j)) = d(i,j)[\beta]$ for convenience, we form:

$$(6) \quad V(i,j) = KE(i)A(j)d(i,j)[\beta] \exp(\mathcal{E}(i,j)).$$

Taking logarithms of both sides of Equation 6 yields:

$$(7) \quad \ln v(i,j) = \ln K + \ln E(i) + \ln A(j) + \beta \ln d(i,j) + \mathcal{E}(i,j).$$

Letting

$$y(i,j) = \ln v(i,j)$$

$$m = \ln K$$

$$e(i) = \ln E(i)$$

$$a(j) = \ln A(j)$$

$$x(i,j) = \ln d(i,j) - \overline{\ln d(i,j)}$$

produces the linear model

(8) $Y(i,j) = m + e(i) + a(j) + \beta x(i,j) + \varepsilon(i,j).$

In Equation 8, $y(i,j)$ and $x(i,j)$ are given and $e(i)$, $a(j)$, β are unknown. Estimation by the usual least-squares method yields vectors $(\hat{e}(i))$ and $(\hat{a}(j))$ which, when transformed by taking antilogarithms, yield (biased) estimates of $(E(i))$ and $(A(j))$. That is, $\exp(\hat{e}(i))$ is approximately equal to $\hat{A}(j)$. These estimated parameters will have the same interpretation as provided in the previous section.

If one is willing to make some rather strong assumptions on the distribution of $\hat{e}(i,j)$, a test for the statistical significance of β can be made, and hypotheses about $E(i)$ and $A(j)$ can be tested by the usual (modified) analysis of variance methods. (See References 10, 29.) In addition, various contrasts of population center and park parameters can be tested to sort out homogeneous groupings. See TN 19 for an expanded discussion of these points.

As implied by previous discussion, the Stage I analysis provides information on the relative "importance" of population centers, parks, and location in accounting for the observed total variation in population center to park trips (i.e., visitor flows). For instance, if all $\hat{E}(i)$'s are equal, differences between population centers do not contribute to this variation. Likewise, if all $\hat{A}(j)$'s are equal, differences between parks do not contribute to the total variation in use at least in a simple way (it is possible that the effects of some factors may cancel out). If, on the other hand, some $\hat{E}(i)$'s and/or $\hat{A}(j)$'s are unlike, then some variation in $v(i,j)$ is due to these factors and further investigation into the causes of these differences would be in order. Finally, the magnitude of the distance parameter $\hat{\beta}$ provides location inferences. For example, if $\hat{\beta}$ is negative and large, it indicates that the elasticity of recreation trips with distance is large or, more simply, that visitor flows fall off rapidly with small increments in distance. On the other hand, if $\hat{\beta}$ is identically 0, then (everything else being equal) the same visitor flows would be achieved for a park no matter where it was located. If $\hat{\beta}$ is positive, then the plausibility of the results or the data would be in question.

Stage II: Accounting for Differences in $(\hat{E}(i))$ and $(\hat{A}(j))$

Assume that estimated parameter sets $(\hat{E}(i))$ and $(\hat{A}(j))$ are available from Stage I, where $\hat{E}(i)$ and $\hat{A}(j)$ represent estimates of $E(i)$ and $A(j)$ respectively. Also assume that not all $\hat{E}(i)$'s are the same and not all $\hat{A}(j)$'s are the same. The Stage II problem is to account for differences between $\hat{E}(i)$'s and $\hat{A}(j)$'s. The quantities $(\hat{E}(i))$ and $(\hat{A}(j))$ are

taken to be the dependent variables in multivariate analyses which have as their purpose the selection of a set of independent variables that appear to account for variation in these dependent variables. In the $\hat{E}(i)$ analysis, independent variables consist of various measurable characteristics of population centers which might make one center more emissive than another. In the $\hat{A}(j)$ analysis, independent variables consist of various measurable characteristics of parks which might make one more attractive than another. For applications where few independent variables are involved, standard linear or nonlinear regression approaches might be used; in more complicated problems where many variables are expected to interact in complex ways, the Automatic Interaction Detector Technique (AID) is a useful approach.

While the use of standard regression analysis is commonplace, a few words of explanation about the potential usefulness of the AID technique might be in order. The technique developed by Sonquist and Morgan (see Reference 31) is a multivariate method of analysis which has as its purpose the "classification" of data into homogeneous groups. This empirical method is free of many of the traditional strong, usually false, assumptions implicitly employed in the analysis of data by techniques such as regression analysis. Given a set of data (measured on nominal, ordinal or interval scales) on some "independent" variables, the AID technique determines what variables combine to produce the greatest discrimination in group means of the dependent variable. The total population of observations is divided through a sequence of binary splits into mutually exclusive "terminal" subgroups. At each stage of the sequence, the dichotomization occurs so as to provide the largest reduction in the unexplained sum of squares of the dependent variable. That group means is chosen that account for more of the total remaining sum of squares of the dependent variable than the means of any other possible combination of independent variables. In this way, the mean values of the dependent variable will be as different as possible between groups, but as equal as possible within groups. The output of the analysis is a so-called "tree diagram" which shows the subgroups formed at each iteration, along with associated statistics. (A very readable example of the use of AID in a marketing context is given by Assael, see Reference 2. Cesario, see Reference 9, discusses a hypothetical use of AID in the present context.)

The relevance of this AID technique to the Stage II problem is obvious. Using emissiveness and attractiveness factors estimated in Stage I for large numbers of population centers and parks, respectively, together with data on particular population center and park characteristics hypothesized to give rise to emissiveness and attractiveness differentials, AID is used to "classify" population centers and parks into homogeneous groupings. Beyond the informative aspects of these AID results - finding out which variables are important and which are not - it becomes possible for

planning purposes to make informed estimates of the attractiveness of any new or altered parks for which appropriate measurements are available, and to assess the associated park use implications. This systematic approach may be contrasted with the procedure of defining attractiveness in an ad hoc way. (See TN 1 and others cited there.) It follows that results of AID analysis will provide researchers with a more objective basis for the construction of improved visitation models.

DATA BASE

To implement the proposed two-stage methodology described in the previous section, it was necessary for the Stage I analysis to construct (v(i,j)) and (d(i,j)) matrices for one or more visitor types in a particular Canadian region, and for the Stage II analysis to collect information on the characteristics of population centers and parks in the region.

The Study Region

For statistical reasons it was desirable to select a study region for which a reasonably large data tableau of the type shown in Table 1 could be constructed. To minimize bias it was desirable to also work with a matrix containing as many positive (hopefully large) entries as possible. Recall that the parameters $\hat{E}(i)$ and $\hat{A}(j)$, which are antilogarithms of $\hat{e}(i)$ and $\hat{a}(j)$ respectively, are biased estimates of $\hat{E}(i)$ and $\hat{A}(j)$. This bias is attributable to the fact that in the "log-linear" model given by Equation 8 undue weight is given to small visitor flows.

Existing data sources were examined with bias and other considerations in mind. After examining the potential for each region in Canada to provide an appropriate data base for estimation purposes, it was determined that the region of Southern Ontario bordered roughly on the North by the cities of North Bay and Sudbury, on the East by Ottawa, on the South by Lakes Ontario and Erie, and on the West by Lake Huron and Georgian Bay, would be suitable. This region is shown in Figure 1. The region of Southern Ontario contains recreation parks operating under several different jurisdictions, - e.g., Parks Canada, Ontario Provincial Government and various Conservation Authorities. Unfortunately, due to paucity of data it was not possible to include all of the region's parks in the study. Concentration was focused on the analysis of data for as many provincial parks as possible.

Visitor Types

Consistent with the Canadian Outdoor Recreation Demand Study classification, visitors to recreation areas can be broken down into the following types:

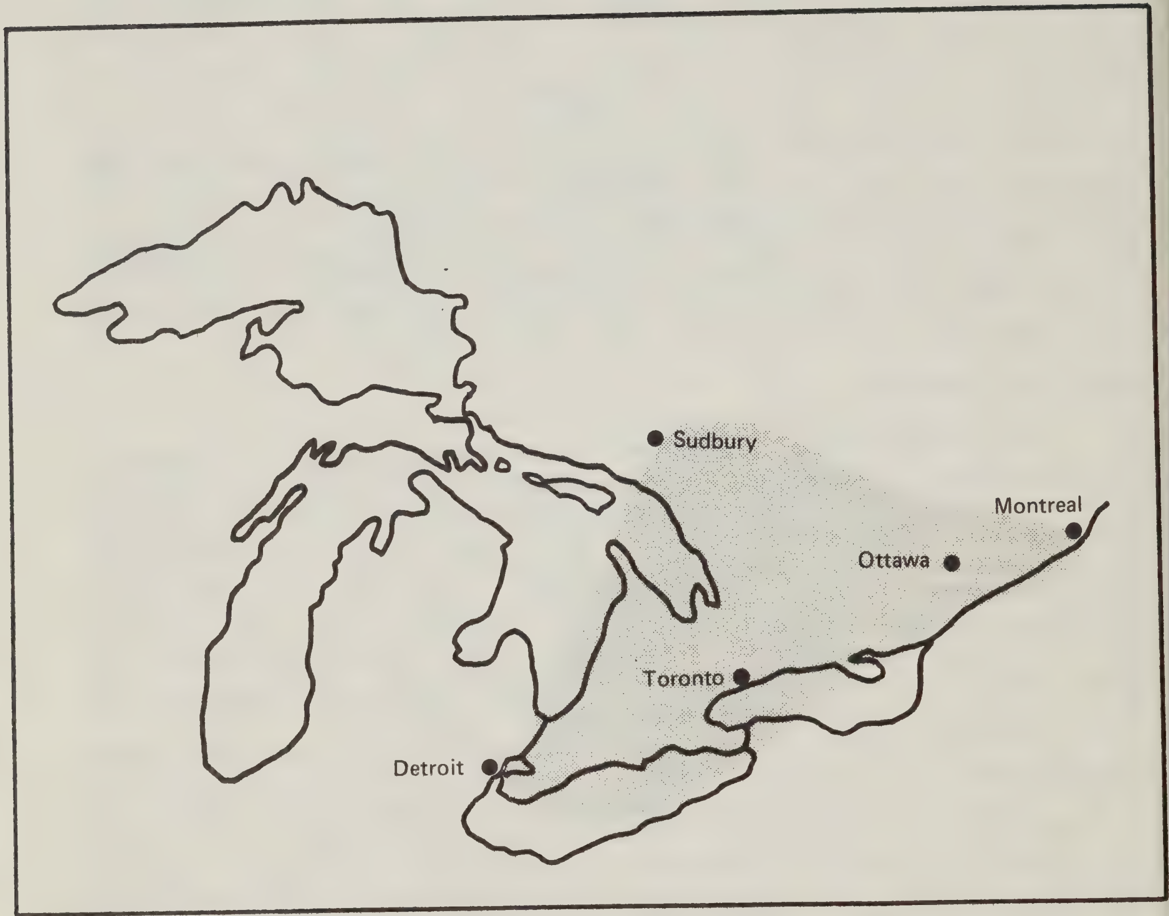

FIGURE 1

STUDY REGION

A. Day-use, main destination
B. Day-use, stopover
C. Overnight-use, main destination
D. Overnight-use, stopover

Visitor type A (day-use, main destination) is represented by that party which originates a recreation trip at home, visits only one park and returns home on the same day. Visitor type B (day-use, stopover) leaves home and visits two or more sites on the same day before returning home. Visitor type C (overnight-use, main destination) embarks on a camping trip from home and travels to one and only one camping site before returning home after completing the stay. Visitor type D (overnight-use, stopover) is typified by vacation campers. This party leaves the home and whether or not an ultimate single destination is the goal, stops for short periods of time at many different campgrounds on a single trip before returning home. Each of the above visitor types is motivated by a different set of factors (each has different amounts of leisure time available for the trip) and conceivably can be considered separately for modeling purposes. It is important to note that the methodology being applied in this study is most relevant for the analysis of the trip-making patterns of visitor types A and C. Attention was focused, then, on securing data with which to construct (v(i,j)) matrices for one or both of these visitor types.

In connection with Visitor Type A, data for day-use visitor types at thirty-five parks were available from CORD Study surveys conducted in 1969; however, there were problems in defining relevant sampling rates. In addition, 1971 data (10 percent sampling rate) were available from the Ontario Department of Lands and Forests (ODLF). Due to very serious problems in establishing the populations to which the observations in both surveys belonged (i.e., total visitor flow by type at a park on any given sampling day) these data could not be used with any confidence as indicators of actual day-use trip patterns and levels.

With reference to Visitor Type B, camper data for main destination and stopover types were also available from CORD Study tabulations. Further, the ODLF provided detailed tabulations based on a 100 percent canvass of camping permits issued during 1968. Unfortunately, ODLF data were not broken down into main destination and stopover categories. The sample did, however, provide an accurate estimate of the total population of campers (the CORD Study data on campers and day-use visitors suffer from problems in defining sampling rates).

In collaboration with the Outdoor Recreation Research Section, Parks Canada, it was decided that Visitor Type C (main destination campers) would be the most appropriate group to consider in the pilot study. A mixture of CORD Study and ODLF data were then used to construct a relevant matrix, (v(i,j)). The ODLF data were used to define an initial (v(i,j)). But since the ODLF camper data do not

distinguish between main destination and stopover use, a correction procedure, based on an analysis of CORD Study main destination/stopover data, was developed to separate the ODLF camper quantities into estimates of the number of campers in main destination and stopover categories. This procedure is described in the Appendix.

Compilation of the Data Set

The population centers chosen for use in this study were 46 cities in the region shown in Figure 1 having a 1970 population greater than 9,000, according to Statistics Canada estimates (i.e., N = 46). In addition to population sizes, average income data were the only socio-economic information available for use in the Stage II analysis. (Actually, data on average income were only available for 30 out of the total of 46 population centers.) Table 2 presents a list of the 46 Southern Ontario population centers used in the study with population data and average income estimates that were available.

For the 46 population centers identified in Table 2, it was possible to compile main-destination camper estimates for 50 provincial parks in the Southern Ontario region (i.e., M = 50). In anticipation of the Stage II analysis, data on park characteristics were collected from various published reports of ODLF and others. Information on 15 characteristics was available for each of the 50 parks included in the study. Table 3 presents the park characteristics information collected and gives the coding system used in the AID analysis. Table 4 lists the 50 parks included in this study along with (coded) associated characteristics.

The (46 x 50) initial camper matrix (v(i,j)), as compiled from ODLF records, is available upon request. These data include both main destination and stopover users. For input to Stage I of the analysis, an estimate of the main destination component of each element of this aggregate (v(i,j)) matrix was extracted by use of the procedure described in the Appendix.

Road mileage over the route of minimum distance was used as the relevant measure of the spatial separation between population center i and park j, d(i,j). These data were compiled by the Outdoor Recreation Research Section using DHO highway link data supplied by ODLF. The (46 x 50) matrix (d(i,j)) used in the analysis can be obtained from the Socio-Economic Research Division, Parks Canada.

TABLE 2

POPULATION CENTER DATA

Code No.	Population Center (City)	Population 1969(a)	Ave. Income 1969(b)
1	Brantford	62,594	5,888
2	Ottawa	297,701	6,992
3	St. Thomas	24,520	5,900
4	Leamington	10,082	-
5	Windsor	198,997	6,969
6	Kingston	59,029	6,138
7	Owen Sound	18,189	5,482
8	Burlington	78,590	-
9	Georgetown	14,964	-
10	Oakville	58,007	7,936
11	Belleville	34,190	6,146
12	Trenton	14,251	-
13	Chatham	34,158	6,306
14	Wallaceburg	10,637	-
15	Sarnia	56,407	7,264
16	Smith's Falls	9,701	-
17	Brockville	19,565	6,016
18	London	211,699	6,344
19	Simcoe	10,447	-
20	Cobourg-Port Hope	20,163	-
21	Ajax	11,273	-
22	Oshawa	86,185	6,813
23	Whitby	22,103	6,390
24	Woodstock	25,314	5,878
25	Brampton	39,232	6,902
26	Peterborough	57,337	6,277
27	Hawkesbury	9,240	-
28	Pembroke	16,431	5,737
29	Barrie	26,212	6,006
30	Midland	10,646	-
31	Orillia	20,542	5,040
32	Cornwall	46,576	5,455
33	Lindsay	12,483	-
34	Galt	36,734	5,756
35	Kitchener-Waterloo	138,345	6,165
36	Preston	15,385	-
37	Niagara Falls	63,054	6,048
38	Welland	42,622	6,263
39	Guelph	56,603	6,087
40	Hamilton-Dundas	321,277	6,506
41	Aurora	12,338	-

42	Toronto(c)	1,253,000	6,741
43	Newmarket	15,267	-
44	Richmond Hill	27,339	-
45	North Bay	38,966	5,990
46	Sudbury-Copper Cliff	92,131	6,371

(a) Source: Estimated from 1966 and 1971 data provided in Ontario Population Statistics, 1971, prepared by Planning Research Section, Municipal Planning and Development Branch, Urban and Regional Development Division.

(b) Source: Inside Taxation, 1972, a publication of the Department of National Revenue and Taxation.

(c) Includes Agincourt, Etobicoke, Don Mills, New Toronto, Scarborough, West Hill, Willowdale, and Toronto Proper.

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TABLE 3

PARK CHARACTERISTICS CODES

Variable	Description	Codes
X1	Number of acres	1 = 0-183 acres 2 = 184-849 acres 3 = 850 acres or more
X2	Number of camping units	1 = 0-100 units 2 = 101-275 units 3 = 276 units and over
X3	Length of swimming beach	1 = 0-800 feet 2 = 801-1900 feet 3 = 1901 feet or more
X4	Park class	1 = Recreational 2 = Natural Environment 3 = Primitive
X5	Acres of picnick area	1 = 0-2.5 acres 2 = 2.6-35 acres 3 = 36 acres or more
X6	Miles of hiking trails	1 = 0 miles 2 = 1 mile or more
X7	Availability of modern comfort stations	1 = Yes 2 = No
X8	Availability of museums/ exhibition centers	1 = Yes 2 = No
X9	Availability of boat-launch ramps	1 = Yes 2 = No
X10	Availability of boats for hire	1 = Yes 2 = No
X11	Availability of trailer sanitary stations	1 = Yes 2 = No
X12	Availability of showers	1 = Yes 2 = No

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TABLE 4

CODED CHARACTERISTICS OF 50 ONTARIO PROVINCIAL PARKS

Park	Coded Park Characteristic X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
Rock Point	2	1	2	1	2	1	2	3	1	2	1	2
Mara	1	1	1	1	2	1	1	3	2	2	1	2
Sibbald Point	2	3	3	1	3	2	1	1	1	2	1	2
Earl Rowe	3	3	3	1	3	1	1	3	1	2	1	2
Craigleith	1	2	3	1	2	1	1	2	2	2	2	2
Inverhuron	2	3	3	2	2	1	2	3	1	2	2	2
Point Farms	2	2	2	1	2	1	1	3	1	2	2	2
Sauble Falls	1	2	1	1	2	1	1	3	2	2	1	2
Bass Lake	1	2	1	1	2	1	1	3	1	2	1	1
Selkirk	1	2	2	1	2	1	2	3	1	2	1	2
Devil's Glen	1	1	1	1	2	1	2	3	2	2	2	2
Turkey Point	2	3	2	2	2	1	1	3	1	2	1	2
Wheatley	2	2	3	1	2	1	1	3	1	2	1	2
Rondeau	3	3	3	2	3	2	2	1	1	2	1	2
Holiday Beach	2	1	2	1	3	1	1	3	1	2	1	2
Ipperwash	1	2	2	1	2	1	1	3	1	2	1	2
Long Point	2	3	2	1	2	1	1	3	1	2	1	2
Pinery	3	3	3	2	2	2	2	3	2	1	2	2
Antoine	1	1	1	1	2	1	2	3	1	2	1	2
Samuel de Champlain	3	2	2	2	2	2	2	2	1	2	1	2
Marten River	3	2	2	1	3	1	1	3	1	2	1	2
Mississagi	3	1	2	2	2	1	2	3	1	2	1	2
Chutes	2	1	1	1	2	2	2	3	2	1	1	1
Killarney	3	2	2	2	1	2	2	3	1	1	1	2
Windy Lake	2	1	3	1	3	1	2	3	1	2	1	2
Fitzroy	2	2	1	1	2	1	1	3	1	2	1	2
Rideau River	1	2	2	1	2	1	1	3	1	2	1	2
Silver Lake	1	2	1	1	1	1	1	3	1	2	1	2
South Nation	1	1	1	1	2	1	2	3	1	2	2	2
Six Mile Lake	1	2	1	1	2	1	2	3	1	2	1	2
Balsam Lake	3	3	2	1	2	2	1	3	1	2	1	2
Darlington	2	3	2	1	3	1	1	1	1	2	1	2
Emily	1	2	2	1	2	1	1	3	1	2	1	2
Presqu'ile	3	3	3	2	3	2	1	1	2	2	1	2
Serpent Mound	1	2	1	2	2	1	1	2	1	2	1	2
Arrowhead	3	2	2	1	1	1	1	3	1	2	1	2
Grundy Lake	3	3	3	2	2	2	1	3	1	2	1	2
Killbear Pt	3	3	3	2	2	2	2	3	1	2	1	2
Mikisew	1	2	2	1	2	1	2	3	1	2	1	2
Restoule	3	2	3	2	1	1	2	3	1	2	1	2
Sturgeon Bay	1	1	1	1	1	1	2	3	1	2	1	2
Algonquin	3	3	3	1	2	2	2	3	1	2	1	2
Carson Lake	1	1	1	1	1	1	2	3	1	2	1	2
Bonnecherre	2	1	2	1	1	1	1	3	1	2	1	2

Black Lake	1	2	1	2	2	1	1	3	1	2	1	2
Bon Echo	3	3	3	1	2	2	2	3	1	2	1	2
Lake St. Pete	1	1	2	2	2	2	1	3	1	2	1	2
Outlet Beach	2	3	3	1	3	1	1	3	1	2	1	2
Oastler Lake	1	2	1	1	1	1	2	3	1	2	1	2
Driftwood	2	1	3	1	1	1	2	3	1	2	1	2

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EMPIRICAL RESULTS

The results of applying the previously described two-stage methodology in the analysis of the Southern Ontario data are described in this section. Results for each stage of the analysis are given separately.

Stage I Results

Parameters of Equation 8, the transformed version of Equation 6, were estimated both for "unadjusted" and "adjusted" v(i,j) data. The distance function h(d(i,j))=d(i,j)**β was used in both cases. The estimates of K and β are given in Table 5. Recall that unadjusted data include both main destination and stopover campers, while adjusted data are estimates of main destination campers only.

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TABLE 5

STAGE I ESTIMATES OF K AND β

	Parameters	
	K	β
Unadjusted data	exp(9.878)	-1.291
Adjusted data	exp(10.770)	-1.579

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As suspected, there is considerable correspondence between the two sets of results. The magnitudes of the

estimated values of K are of little importance since K acts merely as a scaling parameter in the model.

As mentioned before, the parameter α connotes certain behavioral implications; hence, the sign and magnitude of its estimated value are of considerable importance. In this analysis, the estimates of α using unadjusted and adjusted data were both significantly different from 0 (beyond the 0.0001 level). The negative α in both cases is in conformance with the usual hypothesis that visitation is a decreasing function of distance; that is, all other things being equal, the farther a park is located away from a population center the fewer will be its visitors. The numerical estimates of α obtained provide a clue as to the particular rate at which visitor flow declines with distance in the system under study.

The estimated emissiveness, $\hat{E}(i)$, and attractiveness, $\hat{A}(j)$, parameters are given in Tables 6 and 7 respectively. Again, results are given for analyses which used both unadjusted and adjusted v(i,j) observations. Since the estimates obtained by using the analysis of convariance procedure to estimate Equation 8 are in natural logarithms, transformed results are also provided. Correspondence between the adjusted and unadjusted results is again apparent. This is not surprising in view of the findings reported in the Appendix. Nevertheless, due to the crudeness of the main destination/stopover adjustment process there are bound to be some irregularities in these tables, especially Table 7. For instance, Chutes gets a relatively high attractiveness value for main destination use even though from an independent analysis it appears that this park, being adjacent to the Trans-Canada highway, serves primarily stopover users. The number of these possible irregularities is hopefully quite small and one would suspect that the AID results would not be very much distorted.

Using the appropriate distributional assumptions, it was determined that the proportions of the total variance in the data accounted for by population centers in the aggregate and by parks in the aggregate wre significantly different from 0. Tests of specific contrasts of emissiveness and attractiveness parameters were not conducted.

The results are interpreted as follows. First, distance (location) is an important determinant of park use at a particular site and should be explicitly considered in decisions concerning the location of parks. It is, of course, no great surprise to learn that park use decreases as distance from population centers increases; any other result would be looked upon with a considerable amount of skepticism. The importance of this result in this study is that by use of the function h(d(i,j)) with an estimated β, the v(i,j) data are essentially "corrected" to eliminate the distance effect. To put it another way, the location effect due to distance (as indicated by the estimated value of β) is essentially removed from the v(i,j) data so that the

TABLE 6

TWO SETS OF CAMPING EMISSIVENESS INDICES
FOR 46 ONTARIO POPULATION CENTERS(a)

Rank	Study Code #	Population Center	Adjusted Data ln($\hat{E}$)	Adjusted Data $\hat{E}$	Unadjusted Data ln($\hat{E}$)	Unadjusted Data $\hat{E}$
1	42	Toronto	3.697	40.326	3.962	52.562
2	40	Hamilton-Dundas	1.943	6.980	2.027	7.591
3	18	London	1.876	6.527	2.097	8.142
4	2	Ottawa	1.796	6.025	2.142	8.516
5	5	Windsor	1.738	5.686	2.126	8.381
6	35	Kitchener-Waterloo	1.534	4.637	1.659	5.254
7	8	Burlington	1.215	3.370	1.309	3.702
8	1	Brantford	1.057	2.878	1.266	3.547
9	22	Oshawa	0.811	2.250	0.864	2.373
10	15	Sarnia	0.778	2.177	1.019	2.770
11	10	Oakville	0.684	1.982	0.722	2.059
12	39	Guelph	0.662	1.939	0.717	2.048
13	37	Niagara Fall	0.528	1.696	0.678	1.970
14	24	Woodstock	0.499	1.647	0.588	1.800
15	25	Brampton	0.448	1 565	0.450	1.568
16	6	Kingston	0.438	1.550	0.545	1.725
17	34	Galt	0.367	1.443	0.396	1.486
18	46	Sudbury-Copper Cliff	0.319	1.376	0.435	1.545
19	26	Peterborough	0.312	1.366	0.344	1.411
20	38	Welland	0.209	1.232	0.294	1.342
21	13	Chatham	0.205	1.228	0.322	1.380
22	3	St. Thomas	-0.003	0.997	0.058	1.060
23	45	North Bay	-0.069	0.933	-0.029	0.971
24	29	Barrie	-0.278	0.757	-0.313	0.731
25	11	Belleville	-0.296	0.744	-0.331	0.718
26	9	Georgetown	-0.411	0.663	-0.449	0.638
27	41	Aurora	-0.568	0.567	-0.625	0.535
28	17	Brockville	-0.574	0.563	-0.681	0.506
29	36	Preston	-0.630	0.533	-0.678	0.508
30	23	Whitby	-0.654	0.520	-0.762	0.467
31	44	RichmondHill	-0.686	0.504	-0.798	0.450
32	21	Ajax	-0.747	0.474	-0.837	0.433
33	20	Cobourg-Port Hope	-0.755	0.470	-0.863	0.422
34	14	Wallaceburg	-0.802	0.448	-0.939	0.391
35	7	Owen Sound	-0.815	0.443	-0.853	0.426
36	4	Leamington	-0.851	0.427	-0.952	0.386
37	43	New Market	-0.876	0.416	-0.980	0.375
38	32	Cornwall	-0.886	0.412	-1.029	0.357

39	19	Simcoe	-0.999	0.368	-1.116	0.328
40	12	Trenton	-1.012	0.363	-1.162	0.313
41	31	Orillia	-1.168	0.311	-1.272	0.280
42	33	Lindsay	-1.317	0.268	-1.488	0.226
43	28	Pembroke	-1.408	0.245	-1.602	0.201
44	27	Hawkesbury	-1.563	0.210	-1.957	0.141
45	16	Smith Falls	-1.713	0.180	-2.067	0.127
46	30	Midland	-2.031	0.131	-2.235	0.107

(a) In this table the population centers are ranked according to emissiveness values using adjusted data.

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estimated E(i)'s and A(j)'s represent the quantities that would be found to prevail if distance between every population and every park were equal. This interpretation of E(i) and A(j) is completely consistent with the interpretation provided in the operational definitions of these concepts provided earlier.

One conclusion from these results is that the nature of the population centers having access to a park should be explicitly considered in planning decisions. Take any two population centers, for example London and Hamilton-Dundas to the east of London. The Stage I analysis showed (Table 6) that these two population centers are approximately equal in emissiveness. This means that if a park were equally distant from each of these population centers, ceteris paribus, it would be expected to receive the same number of visits from London that it would receive from Hamilton-Dundas. On the other hand, consider the comparison between London and Sarnia, a population center to the west of London. It is seen from Table 6 that London is about three times as emissive as Sarnia. A park equidistant from these two population centers would therefore receive a greater share of its visits from London. If virtually the same park were being contemplated for location in either of the above sites, its use by the three population centers would clearly be maximized at the former site, i.e., at a position equidistant from London and Hamilton-Dundas. (Of course, the real-world analysis is not so simple since many other population centers are involved and the ceteris paribus clause is in general violated; the distance or location effect must be incorporated explicitly into the analysis.)

It has been shown that the nature of parks significantly influences use patterns. Take any two provincial parks, say Rondeau and Black Lake. The Stage I analysis showed (Table 7) that Rondeau is about twice as attractive as Black Lake. This means that, ceteris paribus, Rondeau would draw twice as many visitors from a city as would Black Lake, indicating that Rondeau is twice as "popular" based upon the analysis of these data. Other

similar comparisons could be made using the results depicted in Table 7.

Stage II Results

The questions raised by Stage I revolve around what makes one population center more or less emissive than others and what makes one park more of less attractive than others. To answer these questions multivariate analyses were performed in Stage II to relate the emissiveness and attractiveness indices of Tables 6 and 7 to particular characteristics of population centers and parks, respectively.

Emissiveness Analysis

Due to the limited amount of data available on population center characteristics, it was decided that regression analysis was the appropriate method of relating camping emissiveness indexes to population center factors. Two regression runs were made. The first run tested the relationship

$$Y(i) = b0 + b1\ lnP(i) + \hat{e}(i) \tag{9}$$

WHERE

$$Y(i) = ln\ (\hat{E}(i))$$

$$P(i) = \text{population of center } i$$

$$b0,\ b1 = \text{parameters}$$

using all forty-six population centers as observations. The second run tested the relationship

$$Y(i) = b0 + b1(lnP(i)) + b2(lnI(i)) + \hat{e}(i) \tag{10}$$

WHERE $I(i)$ represents average income of population center i and b2 is an additional parameter. In both of the runs, emissiveness indexes obtained from Stage I using adjusted $v(i,j)$ data were used. The BMD stepwise regression program was employed. Table 8 contains the results of the two runs.

It is seen that population is an overwhelmingly important and statistically significant explanatory variable. Results of run 1 (with 46 observations)) and the first step of run 2 (with 30 observations are similar and indicate that in this outdoor recreation system, population accounts for about 76 percent of the total variance in emissiveness. Furthermore, it is clear that emissiveness appears to be directly proportional to population. From step 2 of run 2 it is seen that the income variable is unimportant.

A plot of $ln(\hat{E}(i))$ versus $ln(P(i))$ using all 46 observations shows the functional relationship obtained from

TABLE 7

TWO SETS OF CAMPING ATTRACTIVENESS INDICES
FOR 50 ONTARIO PROVINCIAL PARKS(a)

Rank	Code #	Provincial Park	Adjusted Data $\ln(\hat{A})$	Adjusted Data $\hat{A}$	Unadjusted Data $\ln(\hat{A})$	Unadjusted Data $\hat{A}$
1	42	Algonquin	2.952	19.144	3.115	22.533
2	38	Killbear Poi	1.805	6.080	1.914	6.780
3	37	Grundy Lake	1.729	5.635	1.924	6.848
4	18	Pinery	1.356	3.881	1.349	3.854
5	49	Oastler Lake	1.186	3.274	1.248	3.483
6	48	Outlet Beach	0.867	2.380	0.861	2.366
7	46	Bon Echo	0.771	2.162	0.833	2.300
8	23	Chutes	0.747	2.111	1.020	2.773
9	21	Marten River	0.730	2.075	0.990	2.691
10	39	Mikisew	0.665	1.944	0.747	2.111
11	9	Bass Lake	0.635	1.887	0.673	1.960
12	34	Presqu'ile	0.582	1.790	0.638	1.893
13	40	Restoule	0.451	1.570	0.465	1.592
14	14	Rondeau	0.433	1.542	0.446	1.562
15	36	Arrowhead	0.425	1.530	0.528	1.696
16	8	Sauble Falls	0.367	1.443	0.316	1.372
17	41	Sturgeon Bay	0.305	1.357	0.369	1.446
18	35	Serpent Moun	0.290	1.336	0.323	1.381
19	30	Six Mile Lak	0.274	1.315	0.282	1.326
20	6	Inverhuron	0.232	1.261	0.128	1.137
21	16	Ipperwash	0.199	1.220	0.214	1.239
22	27	Rideau River	0.132	1.141	0.332	1.394
23	20	Samuel de Ch	0.131	1.140	0.287	1.332
24	28	Silver Lake	0.080	1.083	0.143	1.154
25	5	Craigleith	0.080	1.083	0.102	1.107
26	31	Balsam Lake	0.049	1.050	0.000	1.000
27	33	Emily	−0.044	0.957	−0.052	0.949
28	2	Mara	−0.102	0.903	−0.099	0.906
29	26	Fitzroy	−0.128	0.880	−0.018	0.982
30	3	Sibbald Poin	−0.157	0.855	−0.159	0.853
31	50	Driftwood	−0.166	0.847	−0.039	0.962
32	17	Long Point	−0.190	0.827	−0.330	0.719
33	45	Black Lake	−0.256	0.774	−0.233	0.792
34	32	Darlington	−0.363	0.696	−0.333	0.717
35	22	Mississagi	−0.373	0.689	−0.341	0.711
36	24	Killarney	−0.376	0.687	−0.345	0.708
37	4	Earl Rowe	−0.438	0.645	−0.303	0.739
38	7	Point Farms	−0.489	0.613	−0.579	0.560
39	12	Turkey Point	−0.653	0.520	−0.790	0.454
40	47	Lake St. Pet	−0.838	0.433	−0.996	0.369
41	29	South Nation	−0.895	0.409	−0.915	0.401
42	43	Carson Lake	−0.918	0.399	−0.937	0.392
43	44	Bonnecherre	−1.158	0.314	−1.301	0.272

44	25	Windy Lake	-1.183	0.306	-1.466	0.231
45	11	Devil's Glen	-1.215	0.297	-1.326	0.266
45	13	Wheatley	-1.215	0.297	-1.447	0.235
47	15	Holiday Beac	-1.219	0.296	-1.472	0.229
48	19	Antoine	-1.349	0.259	-1.582	0.206
49	1	Rock Point	-1.551	0.212	-1.668	0.189
50	10	Selkirk	-2.203	0.110	-2.519	0.081

(a) In this table the parks are ranked according to attractiveness values using adjusted data.

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TABLE 8

EMISSIVENESS REGRESSION RESULTS

Run	Step	Parameters	Std. Error	R^2	S. E. of Estimate
1	1	b0 = - 9.742	-	0.7677	0.5588
		b1 = 0.926	0.07676		
2	1	b0 = -10.689	-	0.7563	0.5794
		b1 = 1.007	0.10799		
	2	b0 = - 8.808	-		
		b1 = 1.017	0.12749	0.7566	0.5898
		b2 = - 0.229	1.38526		

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run 1 is not as good as one might expect. Extreme values are fit well, but there is still much dispersion about the prodicted straight line. Examination of the residuals uncovered no unusual departures from the assumed distribution, and no sub-regional pattern of residuals were apparent.

That population is such an important influence in recreation trip-making is not surprising; this result merely confirms what many have intuitively sensed over the years. It may be possible, by disaggregating population in different ways, or by including additional variables, or by using different functional forms, to account for additional variance in emissiveness. But it can be effectively argued that, based on the above results, these refinements could easily be judged unnecessary, especially in view of the

crude nature of the population estimates used in the analysis.

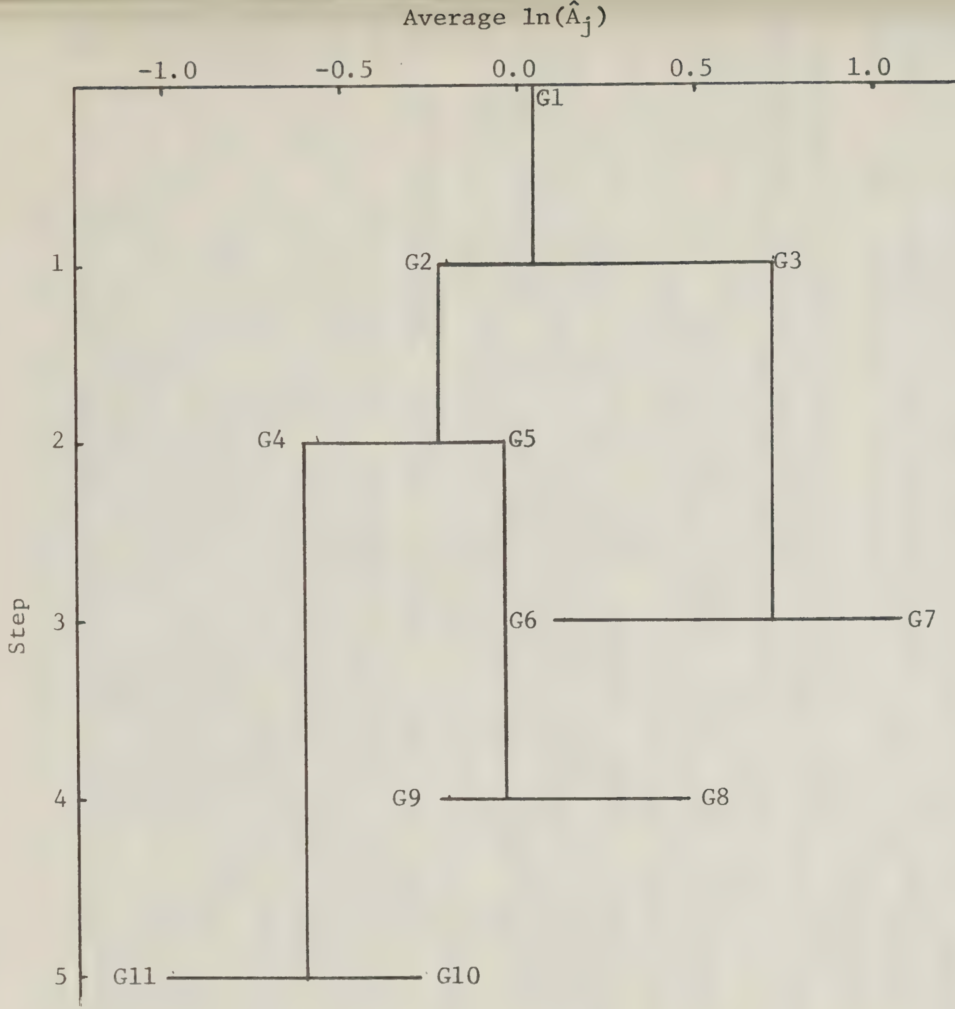
Attractiveness Analysis

Data on park characteristics were somewhat more plentiful than was the case with data on population centers. Therefore, it was reasonable to employ AID to find those park characteristics that were most closely associated with differences in attractiveness. The particular park characteristics employed in the analysis were given in Tables 3 and 4.

For exploratory purposes, results were obtained for both adjusted and unadjusted Stage I attractiveness results. It turned out, however, that the Stage II results were nearly identical. Thus, only results from using the adjusted data are reported. The AID tree diagram for the AID analysis using adjusted data is given as Figure 2. (It is important to note that in this run the stopping rule used was such that as soon as a split resulted in a subgroup with fewer than twelve observations, no further splits were allowed.)

Figure 2 is interpreted as follows. Group 1 (G1) is the total population of 50 observations (i.e., n1 = 50). The mean value of the dependent variable, the logarithms of the Stage I attractiveness estimates, is ml = 0.035. After examining all possible binary splits for each possible "independent" variable in Table 3, the maximum reduction in the unexplained sum of squares is obtained by splitting Group 1 on the basis of "total park acreage". All those parks with 850 acres or less are in Group 2 (n2 = 35); all those parks with greater than 850 total acres are in Group 3 (n3 = 15). The mean attractiveness value for Group 2 is m2 = -0.241; the mean attractiveness value for Group 3 is m3 = 0.681. The horizontal axis of the tree diagram is scaled accordingly.

After Step 1, additional binary splits are formed by applying exactly the same procedure to Groups 2 and 3 that was applied to the original set of data, Group 1. Then the procedure is again applied to the subgroups formed at the end of Step 2; and so on down the line. The vertical axis of the tree diagram thus shows the groups that were formed at each step of the analysis. For example, Groups 4 and 5 were obtained by splitting Group 2 on the basis of "number of campsites". On the other hand, Groups 6 and 7 were formed by splitting Group 3 on the basis of "length of swimming beach". Thus while total acreage is the most influential variable in accounting for differences in park attractiveness, the second most influential variable is "number of campsites" for parks with a total acreage of 850 acres or less and "length of swimming beach" for parks with a total acreage of greater than 850 acres. This result could be interpreted in a number of different ways. Most likely, a "severe" interaction has been detected; that is, the relative importance of an independent variable depends on



Splitting Variable	Splitting Groups
Number of acres	$X_1 = \{1,2\}, \{3\}$
Number of camping units	$X_2 = \{1\}, \{2,3\}$
Length of beach	$X_3 = \{1,2\}, \{3\}$
Length of beach	$X_3 = \{1\}, \{2,3\}$
Length of beach	$X_3 = \{1\}, \{2,3\}$

FIGURE 2. AID CLASSIFICATION TREE FOR 50 ONTARIO PROVINCIAL PARKS

the levels of its predecessors.

Severe interaction occurs whenever both the upper and lower branches of an AID tree split on different variables; "mild" interaction occurs when upper and lower branches split on the same variable. For example, continuing down the AID tree of Figure 2, it is seen that at high coded values of X2, the next-best variable is X3 (length of swimming beach). Similarly, for lower codes of X2 the next best variable is X3. The difference between the average value of attractiveness in group 9 (i.e., -0.224) and the average value of attractiveness in group 8 (i.e., 0.306) can be construed as a measure of the "main effect" of X3 at high levels of X2. The corresponding difference for groups 11 and 10 gives an estimate of the main effect of X3 at low levels of X2. The difference between these two differences then provides the conventional statistical measure of the interaction between X2 and X3. If this difference of differences is negligible, then there is no interaction. If, on the other hand, the difference between average attractiveness of groups 8 and 9 is markedly different from the difference between the average attractiveness values for groups 11 and 10, then the interaction is large. Under suitable assumptions, the statistical significance of the magnitude of this interaction can be assessed. In the AID tree of Figure 2, the difference of the differences is equal to 0.255, and there is thus some evidence of a mild interaction.

Figure 2 shows that a total of six terminal groups were formed: these are groups numbered 6, 7, 8, 9, 10 and 11. Each of the original observations belongs to one (and only one) of these terminal groups. Table 9 gives some relevant information for each group. The groups are arranged according to group means. Each terminal group is defined by a particular combination of codes for independent variables. For example, group number 9 of Figure 2 is seen to be defined by X1 = (1,2), X2 = (2,3), and X3 = (2,3). No other independent variables are required to define terminal group 9. Enumeration of all terminal groups in the above fashion shows that even in this simple structure, the terminal groups are defined by widely different combinations of characteristics. Table 10 presents the parks contained in each of these groups. Tables 9 and 10 illustrate a common and interesting result: two terminal groups (9 and 10) have mean attractiveness values that are approximately equal. Yet each group is defined by a different set of characteristics.

Splits were obtained on only three of the thirteen independent variables. Due to the relatively small sample size and particular stopping rule used in this analysis, further splits would be impossible to obtain. It is possible to conclude, however, that the three variables for which splits were obtained are the most important discriminatory variables in this sample; it is conceivable that with a larger sample size, other less important variables might be

TABLE 9

TERMINAL GROUPS FORMED BY AID
CLASSIFICATION TECHNIQUE

Terminal Group #	# Observations	Mean Value Attractiveness Log	Transf.	Defining Characteristics
7	9	1.071	2.918	X1=(3),X3=(3)
8	8	0.306	1.358	X1=(1,2),X2=(2,3), X3=(1)
6	6	0.097	1.102	X1=(3),X3=(1,2)
9	14	-0.224	0.799	X1=(1,2),X2=(2,3), X3=(2,3)
10	7	-0.233	0.792	X1=(1,2),X2=(1), X3=(1)
11	6	-1.013	0.363	X1=(1,2),X2=(1), X3=(2,3)

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introduced in later stages.

SOME PRACTICAL APPLICATIONS

It was mentioned previously that results of successful applications of the proposed two-stage procedure for identifying important factors accounting for variations in aggregate outdoor recreation trip-making behavior would be useful to both planners and researchers.

An Application for Planners

An important park planning function is the optimum design of park facilities subject to physical, financial and political constraints. In the design of new parks, or of expanded versions of existing parks, the planner is faced with choices. For any particular park he is, of couse, interested in ascertaining the visitor implications of each of several alternative design possibilities: he would like to know for each design possibility how a park would compare with other parks in terms of attractiveness. Results such as those provided by this analysis are ideally suited for making these kinds of judgements.

The AID tree shown in Figure 2 may be used to classify

TABLE 10

HOMOGENEOUS GROUPINGS OF 50 ONTARIO PROVINCIAL PARKS AS OBTAINED BY AID ANALYSIS

Terminal Group	Mean Attractiveness Log	Mean Attractiveness Transf	Park Group	
7	1.071	2.918	Algonquin	Presqu'ile
			Killbear Pt.	Restoule
			Grundy Lake	Rondeau
			Pinery	Earl Rowe
			Bon Echo	
8	0.306	1.358	Oastler Lk	Six Mile Lk
			Bass Lake	Silver Lake
			Sauble Falls	Fitzroy
			Serpent Md	Black Lake
6	0.097	1.102	Marten River	Balsam Lake
			Arrowhead	Mississagi
			Samuel de C	Killarney
9	-0.224	0.799	Outlet Beach	Sibbald Pt.
			Mikisew	Long Point
			Invenhuron	Darlington
			Ipperwash	Point Farms
			Rideau River	Turkey Pt.
			Emily	Wheatley
			Craigleith	Selkirk
10	-0.233	0.792	Chutes	Carson Lake
			Sturgeon Bay	Devils Glen
			Mara	Antoine
			South Nation	
11	-1.013	0.363	Driftwood	Windy Lake
			Lake St.Peter	Holiday Bh.
			Bonnecherre	Rock Point

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new observations, i.e., new or improved parks, using only values of the park's relevant independent variables. Suppose, for example, that the coded values of X1, X2 and X3 are given by 1, 3 and 1, respectively for a new park. The park might have, for example, 700 acres, 200 campsites and a swimming beach that was fifty feet in length. The AID tree yields an estimate of the park's attractiveness simply by determining to which terminal group the new observation belongs. Beginning at the top of the AID tree, it is seen that the left branch is taken because X1 = 1 for the new park. At the next split the right branch is taken because X2

= 2. The next branch yields terminal group 9 because X3 = 2. The predicted value of attractiveness for this hypothetical park is graphically seen to be approximately -0.224 in logarithmic terms. Thus an informed estimate of attractiveness is obtained.

If no information were available on the park's particular characteristics as compared to the characteristics of other parks that give rise to differential attractiveness values, the best estimate that could be made would be to assume the average value of the total sample, which from Figure 2 can be seen to be equal to 0.035 (in logarithmic terms). This is, in a sense, an "unconditional" predicted value. When the unique characteristics of the new observation are used in the assessment, the "conditional" prediction thereby obtained represents a substantial refinement over an unconditional prediction. In this particular case it was seen that a park with the characteristics cited above is less attractive than the average park. Translated into absolute numerical scales, the implied difference in attractiveness magnitudes is about 0.8:1. Interpreted, this implies that (all other things being equal) the new park would draw about eighty percent of the visitors that the "average park" would draw. Planning can be performed more effectively by making use of this information.

An Application for Model Building

Several approaches for relating park use to the factors which "explain" it were alluded to in the Introduction. It was noted that researchers have attempted to construct models which use as dependent variables various measures of park use and as independent variables various suspected influencing factors. Independent variables that are specific to population centers and to parks are, of course, generally considered to be very relevant. But, due to the virtually infinite number of possible combinations of variables that can be hypothesized to characterize population center and park effects on outdoor recreation park use, the selection of particular variables to include in the models is a difficult undertaking. As a result, subjective ad hoc selection procedures are often adopted. The result provided by this study can be viewed as providing a somewhat objective basis for selecting these relevant variables.

Viewed in this general sort of way, the overall results of the study can be taken as being supportive of previous modeling efforts that have used population and park size-related measures as independent variables. It was found, for instance, from regressions on the $\hat{E}(i)$'s that population size by itself is a very good indicator of population center emissiveness (i.e., participation) and from AID analysis on the $\hat{A}(j)$'s that acreage and other size-related characteristics of parks are reliable indicators of attractiveness (i.e., popularity). These measures may now be used with some justification in models of recreation trip-

making whereas (before) their use was based strictly on what might be termed "informed judgment".

Concentrating on the AID analysis, attractiveness results, in particular, can serve to lead future research and model-building investigations into potentially fruitful directions. For example, regarding the AID classification tree of Figure 2, it was pointed out that both mild and severe interaction existed in the system under study, and that no unique set of variables would be expected to suffice for the modeling of visitor flows to all parks. On the basis of these findings the researcher might proceed to perhaps develop separate regression models for observations in each terminal box and thereby obtain coefficients with which to judge the relative partial effects of the associated independent variables on each subgroup.

GENERAL CONCLUSIONS

The objective of the analysis was to put to test a proposed methodology for drawing certain inferences about important factors influencing park usage. The methodology proved to be a promising way of exploring emissiveness, attractiveness and location - questions that have traditionally plagued park planners and analysts.

As far as specific numerical findings are concerned, two results become clear. Evidence was provided that population size is by itself a useful indicator of participation differences in the region under study. There is thus some justification, then, for using a population measure as a basis for park use models.

On the other side of the coin, park size was seen to be a most important factor in attracting trips to a particular recreation area. It was shown that large parks attract large numbers of people relative to small parks, all other things being equal. Further, the number of camping sites appears to be a very important variable for small parks, whereas length of swimming beach is only important in large parks. It can be concluded that size-related measures are useful as indicators of recreation site attractiveness in modeling efforts. The new two-stage methodology, while having many advantages over existing methodologies that attempt to perform similar analyses, is not without its limitations. To properly assess its ultimate usefulness, it would be necessary to conduct other tests on a more expanded data set in a large number of regions. But it is possible to systematically list some of the advantages and disadvantages.

Advantages and Limitations

The proposed procedure is, in a sense, economical. First, data requirements for the first stage are quite meager - only matrices ($v(i,j)$) and ($d(i,j)$) are required. And if significant differences do not appear in the

estimates ($\hat{E}(i)$) and ($\hat{A}(j)$) after application of Stage I, the second stage of the analysis need not be undertaken, consequently effecting a savings in data collection costs since population center and/or park characteristics data would not be required.

It is clear that classification is regarded as a central requirement of the approach tested in this report. In this respect, the AID technique used in Stage II has many advantages over other methods of analysis in that it determines the joint effects of many variables by analyzing variance between grouped data by making the very minimal number of statistical and algebraic assumptions. Other methods such as regression analysis require very strong assumptions that are believed to be satisfied only infrequently in the analysis of nonexperimental data. Other advantages of AID, such as the detection of "mild" and "severe" interactions, have already been mentioned.

By far the most useful feature of the methodology under test here is the systematic extraction, from observed data on recreation choices, of factors influencing park use. That is, the underlying assumption is that these factors are revealed by people who make observable choices in their recreational pursuits. This "deductive" sort of reasoning stands in contradistinction to the "inductive" reasoning that has characterized many previous modeling studies.

There are, of course, many real limitations of both stages of the analysis. In the first stage, transformation of the model (Equation 6) into logarithmic form produces biased estimates of its parameters. Estimation in Stage I by Equation 8 is difficult when there are many zeros in an observed spatial interaction matrix since the logarithm of 0 does not exist. Finally, due to possible heteroscedasticity problems the hypothesis-testing procedures, if applied, can be rendered invalid. The potential user of this methodology should take these considerations into account.

[With regard to the second stage of the analysis, the AID classification technique produces results that are not easily interpreted in the analysis of trip-making systems of small dimension. And since the method produces a sequence of dichotomous splits, only the best "local" split is obtained at each step of the sequence. Thus a series of locally optimal decompositions is obtained where each split is contingent upon the previous one. It is possible that a variable "far down the line" could be almost as discriminating as one of the first. Had the program plit differently in the beginning, a different AID tree would result (one resolves this problem by running the analysis several times with judicious elimination of variables). The codification of independent variables for AID analysis must also be done judgmentally. Overly coarse coding loses information; overly refined coding can increase computing costs without substantially improving the results.

__Recommendations for Further Research__

All in all, the methodology described in this report appears promising. Only by applying the method to other situations and comparing results with alternative methods can its usefulness be ascertained. The following recommendations for further study can be given:

(1) This pilot study concentrated attention on only one region in Canada. Much can be learned about the [generality of the results by applying the two-stage methodology to analyze corresponding outdoor recreation travel patterns in other regions.

(2) This pilot study concentrated attention on one visitor type - main destination campers. It would be interesting to compare these results with outdoor recreation travel parameters estimated for the other relevant visitor type (main destination day-users) in the same region.

(3) This pilot study used data at its highest level of aggregation - the total visitors travelling from i to j during some long time period. It is possible to explore, by use of the proposed methodology, travel patterns of various population subgroups. For example, it is theoretically possible by use of CORD Study data to identify various characteristics, such as age and income, for each visitor group. It is also possible to pinpoint dates of travel. Understanding of outdoor recreation travel patterns might be enhanced on the basis of some of the above identifiable characteristics. Perhaps even an analysis of individual trip-makers could be attempted.

(4) The Stage I analysis produces biased estimates of parameters. Work is proceeding by this author toward the development of an estimation technique not fraught with the many problems of using an alysis of covariance on a transformed version of the postulated model. When this work is completed, the new methodology should be used to at least re-estimate the parameters documented in this report.

(5) Stage II results using the AID technique as a statistical tool would call for large numbers of observations. Its usefulness in the outdoor recreation context is therefore jeopardized. Nevertheless it is possible and desirable to increase the data base to a much larger size by incorporating data pertaining to parks under the jurisdiction of other agencies (e.g., various Conservation Authorities). In this regard, work should proceed on coordinating data collection efforts with these agencies.

(6) The two-stage methodology presented in this report

attempts to, first, uncover the structure of some existing data and, second, interpret this structure so that we may come to an understanding of how it might have come about. Other methodologies, some of which were mentioned in the Introduction, purport to answer some of the same questions. (To this author's knowledge no other procedure addresses all of the same questions). A useful exercise would involve a comparison of corresponding results obtained from this study with those obtained from applying other methodologies to the same or similar data.

APPENDIX

MAIN DESTINATION/STOPOVER ADJUSTMENT FUNCTION

Since the camper data provided by ODLF and used in this study do not distinguish main destination and stopover use, a simple adjustment procedure was applied to the v(i,j) data in order to separate these two types of uses. Basically, it is hypothesized that stopover use, as a percentage of total use, declines as the distance between population center and park increases. Therefore, v(i,j) observations associated with large distance measures would have a greater stopover component than observations that are associated with small distances. A function expressing this ideas is:

(A1) $$v'(i,j) = v(i,j) \exp(\alpha d(i,j))$$

where v(i,j) is the observed number of total camper trips from i to j, d(i,j) is the associated distance and v'(i,j) is the estimate of main destination component of v(i,j). The parameter α must be empirically estimated. Note that if d(i,j) is small, v'(i,j) is close to v(i,j) and as d(i,j) gets larger v'(i,j) approaches 0.

Data from the CORD Study surveys were used to estimate α. Population center to park data for twelve parks were employed in the analysis; a total sample of 163 observations was used. It was found that $\alpha = -0.004$ gave the best results, and was significant at the 0.01 level. Unfortunately, the R^2 value associated with this estimate was quite low ($R^2 = 0.40$). The estimated value of $\alpha = -0.004$ does, however, suggest a "half-life" of about 200 miles, that is, when d(i,j) = 200 in Equation A1, then v'(i,j) is approximately equal to v(i,j)/2 and approximately one-half of the observed number of campers are presumed to be main-destination users, the other half being stop-overs.

Each of 2300 (i.e., 26 x 50) v(i,j) observations were adjusted using Equation A1 with $\alpha = -0.004$. Due to the relatively low R^2 value, there was no overwhelming evidence that this procedure provides realistic estimates of main destination users; there are undoubtedly many other factors besides distance which might be included in the adjustment

model. Yet this procedure can be defended on conceptual grounds as well as on the basis that, given the significance of the regression results, some adjustment based on these results was more realistic than no adjustment at all.

In the trip data there were many $v(i,j)$ observations that equalled 0. The prevalence of 0's presents a problem in the log-linear Stage I analysis which uses logarithms of $v(i,j)$ observations as dependent variables. There is no clear-cut resolution to this problem and a compromise procedure was employed to eliminate the possibility of taking the logarithm of zero. Specifically, the Stage I analysis using adjusted (i.e., $v'(i,j)$) and unadjusted (i.e., $v(i,j)$) data employed $\ln(v'(i,j) + 1)$ and $\ln(v(i,j) + 1)$ as dependent variables.

CORD STUDY TECHNICAL NOTE 11

A MODEL OF VISITOR FLOWS CONSIDERING A BASIC PARTICIPATION FUNCTION AND AN "ALTERNATIVE FACTOR": SIMULATION AND PARAMETER ESTIMATION

J. Beaman, H.K. Cheung, and N.H. Do

ABSTRACT

This paper presents what may be called a generalization of the Cesario model, which is designed to show what the behavioural structure may be that is embedded in the parameter that Cesario has called city emissiveness. A function is introduced that is said to be a way of defining Cesario's emissiveness. This function is shown to be plausible in that it reduces to emissiveness in the way one might think of it in the ordinary Cesario model if a city is only served by one site (an isolated site). Also, the function is constructed in such a way that people do not simply double the number of visits they make to parks because a second park is introduced into a system that already has one park even if the new park is as attractive as the original park and at the same distance from the given city.

The estimation problems resulting from the form of the generalization are described. The authors report that original estimation attempts were made which resulted in the discovery of a degeneracy problem in estimation. The nature of this problem is described and two approaches to determining the parameter of the generalized model which in the paper are called inherent emissivenesses of cities, are presented. The one method involves determining coefficients similar to the original Cesario emissivenesses but this time corrected for availability of supply. The other approach is analagous to that explored by Cesario when he tried to explain his emissiveness values by aggregate socio-economic information on cities.

It is not claimed that the modification to the Cesario model improves the model's overall effectiveness in explaining park use. It is pointed out that no more total variance in origin-destination flow data is explained by this generalization than by the original model. Rather, it is suggested that by eliminating effects of supply on Cesario's emissiveness coefficients it is made possible to explain what are called the inherent emissiveness coefficients by using socio-economic characteristics. These parameters are indicated as the ones that should be known when the Cesario model is used to estimate park use in an altered system.

In the way of general critique, it is pointed out that

the Cesario model could be described as not being adequately successful in explaining people's general origin destination flow behaviour. The generalized model is noted as being equally deficient since only the internal structure of the Cesario model has been modified. Some indications are given about why both these models might be deficient so researchers can have a better feel for where the model proposed is applicable and in what other directions research might be focused.

INTRODUCTION

Cesario has presented a gravity model formulation to explain observed outdoor recreation travel patterns between cities (origins) and parks (destination) for overnight camping. The basic concepts behind this model are that: (1) associated with each city is an inherent "emissiveness", E(o), which is a (relative) measure of the degree to which people in that city will participate; (2) associated with each park is an inherent "attractiveness", A(d), which is a (relative) measure of the degree to which people will visit that park; and, (3) visits between any origin and destination decrease with the distance between them. The complete formulation of the model and procedures for estimating the E(o)'s and A(d)'s are given in CORD Study TN 4.

Cesario suggests that the emissiveness and attractiveness parameters computed using his model can be analyzed by explaining them by a function of the socio-economic characteristics of the population in origin areas and a function of park characteristics, respectively. Now, without getting into the issue of whether the suggestion by Cesario meant that he thought that the emissiveness coefficients calculated were dependent

only on the socio-economic characteristics of the population, one may note that it is reasonable to propose that the emissiveness of a city depends on the amount of supply to which it is exposed. It is this relationship that is of concern in this paper when the authors proceed to generalize the Cesario model in such a way as to explicitly introduce a "supply effect" into Cesario's emissiveness coefficient.

There are a number of factors that can be conceptualized as influencing people's use of parks; the ones studied here can be called the "alternative" factor, and the factor of "supply generating demand". One may consider the following example as an aid to understanding what prompts the authors to suggest that there is a need to study the likely influence of alternatives and "the level of supply" on people's behaviour. Suppose a city which is supplied by a single park for camping is given access to another site, with the second park equally as attractive as the first and adjacent to, or at an equal distance but in the opposite direction from the city as the first park. It is possible to conceive that total visits (demand) for the

two parks will be greater than total visits when there was only one park. But, on the other hand, the second site offers the same "good" or camping experience with a given attractiveness at the same price (distance, time, camping fee etc.) as the first park, so "consumption" should not change.

Does the original demand merely divide between the two parks? If not and it increases, does one have the paradoxical situation of supply generating demand?

Of course any paradox in the above example is explained away if one supposes that the alternative park provides variety, which stimulates demand. Further, supply may effect people's awareness or knowledge of the activity, camping, eventually resulting in participation being related to level of supply as indicated in Figure 1. Supply factors frequently influence demand for goods in this manner (see TN 29).

When supply is small one might see that for a slightly larger supply there is a much greater demand. From a dynamic and behavioural perspective, at some point awareness, variety etc. are such that demand "takes off" in relation to supply. Each new facility that is added further serves to convince people that an activity is the thing to do. That is, it is the thing to do up until saturation is reached. Then again, little demand expansion is to be expected when new supply is introduced into a system.

One may note that the type of "s-curve model" shown in Figure 1 is commonly used to explain the dynamic growth in sales when new products are introduced. But, here the concern is not with a dynamic formulation: the concern is with the new equilibrium that will be reached once a new supply has been introduced into a system and people have "totally" adapted to the new configuration.

MODEL SPECIFICATION

Consider, for example, a centre supplied by two sites with a new site equally as attractive as an original site and, say, at an equal distance in the opposite direction. It is possible to think that after the second site was created and its use reached equilibrium, total attendance to the two parks would not be the same as it was at the one park before creation of the second site. In fact one could expect an increase in total use as suggested in Figure 1. What is important about the example just introduced is that, in classical supply-demand terms, the new site offers the same product at the same travel-price, etc., so one might say that consumption should not change. However, the west Texas reservoir creation situation cited in Clawson-Knetsch (see Reference 12) or arguments based on increased utility of trips when a variety of destinations is available suggest that the original use does not merely divide between the two parks when the second park is created. Total attendance at parks is expected to increase: creating supply is expected to "create" demand.

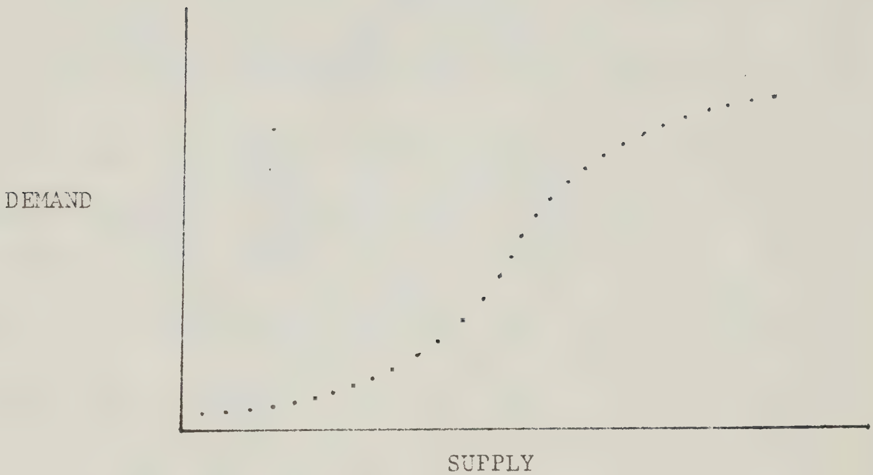

FIGURE 1

EQUILIBRIUM "LEVEL" OF DEMAND (PARTICIPATION) ASSOCIATED WITH SPECIFIC "LEVELS" OF SUPPLY

Deriving the model discussed here is a convenient way to expose the premises on which the SGD (supply generates "demand") model is based. Accept that for an isolated site, the only site serving an origin with a certain experience for which there is no substitute, visitor flows are specified by Equation 1 below:

$$(1) \qquad V(o,d) = F(D(o,d))A(d)AE(o)$$

WHERE

$V(o,d)$ is the flow of some fairly homogenous type of visitors from origin, o, to a destination, d;

$D(o,d)$ is the "distance" from o to d measured in appropriate time-distance units;

$F(\quad)$ is a function expressing the way use varies with "distance";

$A(d)$ is the attractiveness of the destination, d; and

$AE(o)$ is the emissiveness of the origin, o.

Equation 1 is a special case of a more general equation discussed by Cesario (see TN 4). It implies that the amount of visitor flow from a city to the only destination of a given kind that serves it for main-destination tris is dependent on the attractivity of the destination area (see TN 9 and TN 33 on the issue of destination area attractivity) and the distance to the destination, and all this in the context of a certain type of person going to the given park for a given purpose (see TN 33 for more general concerns).

But, one may ask, what happens when there are two parks of differing or similar attractivities at differing or similar distances from a city that service the city in a similar way for a given type of main-destination visits (eg. week-end recreational camping visits)? It is suggested that the total participation that will be generated when new sites are entered into a system is not generally as great as if every site could be treated as an only site, so flows computed using Equation 1 could be added. Rather it is proposed that introducing a new site into a system will (at equilibrium) usually cause total use to rise less than the amount that the new site would receive if it were the only site, but total use trips will be more than there were when only the original site was there.

The ideas already introduced make it convenient to state:

Assumption 1 It is possible and meaningful to speak of a city's isolated absolute emissiveness, AE(o), to a site of unit attractively at zero distance.

In particular, one should note that since the distance functions used here are of the form exp(-aD(o,d)) there is no problem with use becoming infinite as distance goes to zero (as would be the case with D(o,d) to some power). Actually, one does not expect use of parks to increase very rapidly as one goes from being one quarter of a mile from a park to one eighth of a mile. Nor does one expect use to become "infinite" because a person lives in a park. As well, for large distances there are problems with the "distance to a power" function that do not arise when an exponential function is used (the nature of the problem is indicated in TN 14). In this regard, behaviourally the exponential function used makes more sense than using distance raised to some negative power to explain number of trips based on distance travelled.

Assumption 2 following suggests what isolated absolute emissiveness really means.

Assumption 2 The isolated absolute emissiveness of a city to its isolated site is a parameter that expresses the aggregate effect of a number of factors on the level of participation in an activity that the city would generate to its isolated site of unit attractivity at zero distance and it may be defined by one of the following increasingly specific equations:

(2A) AE(o) = F(city size, city-age-sex distribution information, ...)

(2B) AE(o) = C(1,o) POP(o) G(% age-sex distribution, % income distribution, etc.)

(2C) AE(o) = C(2,o) (N(o) U + @E B(i,j) n(i,j))

WHERE now, as in TN 6, N(o) refers to the population of o and n(i,j) is the number of people in o who have level j of socio-economic variable i.

In Equations 2B and 2C above the constants C(1,o) and C(2,o) can be considered to reflect city uniqueness that exists once total population and a population's socio-economic distribution have been considered. Also the reason for having C(1,o) and C(2,o) in the above relates to problems of defining absolute scales and to identification problems in estimation, both of which are commented on subsequently.

In particular, Equation 2C for which a derivation is given in TN 6 implies that AE(o) has a simple form that involves the total potential for participation in an activity being proportional to the number of people in an

origin area and dependent on the socio-economic characteristics of that population (being poor, aged, etc.). In fact, one may suggest that the age, income, etc. effects implied by Equation 2C are corrections that may be applied to any city (see TN 12) while city uniqueness is embodied in C(2,o).

The preceding assumption is important in accepting Assumption 3 which simply restates Equation 1, taking into account the effect of distance to travel to a site and site attractivity:

Assumption 3 If a city is serviced by a single site for a given activity that has no substitutes (see TN 33) then total emissiveness of a city is concentrated on a single site so that actual visitor flows can be calculated if distance and the attractiveness of the site are introduced as indicated in Equation 2:

$$(2)\quad VI(o,d) = \exp(-rD(o,d))\, A(d)AE(o)$$
$$= \exp(-rD(o,d))\, A(d)C(1,o)POP(o)G(o)$$

WHERE r is a constant which may be called the impedance of distance (TN 14),

A(d) is the attractiveness of site d,

G(o) is a correction for population distribution, and

C(1,o) is the per capita isolated site emissiveness in the city.

Now it has already been stressed that the primary concern here is generalizing Equation 2 to an expression that is appropriate when more than one site is considered. Yet the preceding suggests the need to present an expression that reduces to the isolated site equation (Equation 2) when only an isolated site is considered. Also, there is the problem raised earlier of not having the use of each one of several sites be the same as if they were isolated sites serving a city when they all serve a city. So what is needed is that an alternative factor of sorts be defined which expresses how origin emissiveness increases due to alternative destinations being available (on the effect of alternatives see TN 1, 3, 33 and sources cited there). In particular, it is proposed that a form of the type given below is appropriate:

Assumption 4 Attendance at a site from an origin is defined by Equation 3 if it is accepted that destinations are such that it is (1) meaningful to say that they have an attractivity A(d), that is not influenced by other sites being in the system (this is relaxed in TN 33), (2) that single purpose main destination visits are made to the

destinations and (3) capacity of destinations is large enough that it does not influence use levels by affecting attractivity.

(3A) V(o,d) = exp(-rD(o,d))A(d)(PP(o) / @E P(o,d))((@E (P(o,d)/ PP(o)) **SE)**SM POP(o)CG(o)

WHERE
all sums are over d, and r, D(o,d), A(d) and POP(o) are as defined before,

P(o,d) is the product A(d)exp(-rD(o,d)), and

PP(o) is the maximum of the P(o,d) over all d associated with an o, and CG(o) = C(1,o)G(o).

Two alternative ways of writing Equation 3A which are more compact and of importance later are:

(3B) V(o,d) = exp(-rD(o,d))A(d)N(o)M(o)AIU(o)

WHERE
AIU(o) = absolute isolated use PP(o)POP(o)CG(o) which is the flow that would occur to each site or sites with the highest P(o,d) if that site were the only isolated site serving o,

M(o) = (@E (P(o,d)/PP(o,d)) **SE)**SM is the supply-generated-"demand" multiplier which expresses how much the absolute isolated use is inflated due to having more than one site near an origin, and

N(o) = 1/ @E P(o,d) is a prorating ratio which normalizes the total use generated, M(o)AIU(o) according to the magnitude of P(o,d) = exp(-rD(o,d))A(d)

From the subscripts involved in Equation 3B as indicated in Equation 3C, it is possible to see that one has a Cesario-type equation for use of a site from different origins as determined by site attractiveness and origin emissiveness parameters (see TN 4 and References cited there).

(3C) V(o,d) = exp(-rD(o,d)) A(d)E(o)

WHERE E(o) = N(o)M(o)AIU(o)

Though the issue is not pursued here (see TN 33), the preceding discussion can be reworded to give two further generalizations of the Cesario model. One involves introducing a destination alternative factor. Beaman (TN 9) presents empirical evidence that such a function involving the distribution of sites around a given site may be justified. The other generalization has to do with introducing considerations of other activities

(substitutability).

A matter which has not been stressed yet in this paper and which is not discussed subsequently is the importance of recognizing what type of people making what kind of use of parks a given model is appropriate for. In application it is obviously necessary to have data in which attractiveness of a park to fishermen is not confused with attractiveness to "recreational" campers. Also, as stressed elsewhere, weekend and holiday attractiveness should not be confused with week day use attractiveness for recreational camping (see TN 8). Furthermore attractiveness to day-users, non-main destination users etc. should not be confused (see e.g. user definitions in TN 30).

MODEL JUSTIFICATION

In the way of justification for the equations introduced one can note that when an isolated site is considered one sees that from Equation 3, Equation 4C, for use of an isolated site, is easily obtained. Since PP(o) = P(o,d):

(4A) V(o,d) = exp(-rD(o,d))A(d)(PP(o) / @E PP(o))(@E (PP(o)/ PP(o)) **SE)**SM POP(o)CG(o)

WHERE the sums have only one term, the one given for the single origin destination pair (o,d).

(4B) = exp(-rD(o,d))A(d)(1)(@E (1) **SE)**SM POP(o)CG(o)

(4C) = exp(-r(D(o,d))A(d) POP(o)CG(o)

Equation 4C is the equation for the use of an isolated site with attractivity A(d) from an origin o served only by d (see Assumption 3).

It is also easy to see that if one considers several sites Equation 3 implies that the total flow from a city TF(o) = @E V(o,d) is such that all sites receive less than or no more flow than they would when they are isolated sites if SE C 1 and SM ≤ 1.

Specifically:

(5) TF(o) ≤ @E VI(o,d)

since

(6) V(o,d) ≤ VI(o,d)

Where it is easily seen that Equation 6 holds since the factor which inflates actual outflow from a city is less than or equal to the factor that is implicit in the right side of Equation 5. The multipliers of concern satisfy the following relationship:

```
(6A)  M(o)=( @E (P(o,d)/PP(o))**SE)**SM  ≤
            @E (P(o,d)/PP(o))
            for SE  C 1 and SM  ≤  1.
```

This is because by the definition of PP(o) and P(o,d) their ratio is less than one so that even without taking the root SM:

```
(6B)  @E (P(o,d)/PP(o))**SE  ≤  @E (P(o,d)/PP(o))
```

Equality holds for SE = SM = 1. Though there may be a reason to consider SE < 1 and/or SM > 1 as indicated in the review of the chapter, this possibility is not allowed here. One may wonder why the root SM was introduced. The power SM is actually only considered to be less than one here so that if several sites have P(o,d) = PP(o), one does not have equal increase or decrease in flow for each of these sites that is included in or excluded from a system. For example, consider two sites:

```
(6C)  ( @E (1)**SE)**SM = (2)**SM < @E 1 = 2 if SM .NE. 1
```

The doubling of emissiveness indicated by the left side of Equation 6C being 2 if SM equals one illustrates the general concern. As long as all new sites that are introduced into a system are introduced so that their P(o,d) = PP(o), each new site receives as many visits as the site d which originaly had PP(o) = PP(o,d) if SM equals 1. But introducing the root SM changes the model so that use does not "multiply" with the number of sites in the way just indicated.

In inductive terms, Equation 3 defines a system in which the total emissiveness of an origin, reduced for distance effects, is prorated among the various destinations according to the flow that they would receive if they were isolated sites. But they receive a smaller total flow than would be obtained if each site were an isolated site (unless SE = SM = 1 or for special cases if SM = 1). In this context, Equation 3 is interesting to consider when examining the effect of creating a new site.

Consider what happens when a system has one site, d = l, at a distance D(o,d) from a city, this site has an attractivity of Y, SM = 1/2 and SE = 2. When a second site d = 2 with attractivity Y and also at a distance D(o,d) from the city is introduced into the system, say in the opposite direction from o as the first, Equation 4 implies that for both sites the new use at both d = 1 and 2 is:

```
(7)  V(,,N) = ((1**SE + 1**SE)**SM/(1+1)) V(,,o)
            = ((2)**(1/2)/2) V(,,o)
            = .707 V(,,o)
```

WHERE V(, ,N) indicates the new system use at d = 1 or 2, and V(, ,o) refers to old system use at d = 1.

Thus, the ratio of total attendance at the kind of sites considered in the old system to attendance in the new system is:

(8) 2V(, ,N)/V(, ,o) = 2(.707) = 1.414

About 40% more visitors are generated, but the same "good" is offered at the same price and consumption is up by 40% - supply is generating "demand" (participation) - and it is reasonable to suggest that the "supply has generated demand".

Related to this it is interesting to consider the cost-benefit associated with any increased satisfaction of people: are there any psychological benefits that would not have occurred had no new site been in? And, if there are psychological benefits, how would they have differed if the new site had been as attractive but had been located at such a distance that (P(o,d)/PP(o)) = 1/2 so only a much smaller supply generated demand would have occurred (12%). Clearly, there may be advantages in not subsidizing visits that do not benefit people very much.

ESTIMATION

Equation 3 is the kind of equation discussed by Cesario. In the terminology of this paper it is the Cesario type model:

(10) V(o,d) = F(D(o,d))A(d)E(o)

Because of the identity in form between Equation 3C and Equation 10, the attractivities of the sites A(d)'s are numbers which one may believe can be estimated using Cesario's approach and one may also expect that a constant, K, and the impedance of distance coefficient, r, associated with the distance function can be estimated. Caution about whether the r and A(d)'s will be "easily" or "accurately" estimated may relate (1) a bias depending on logarithmic transformations and (2) heteroscedasticity considerations (see TN 19). Still, parameters can at least be estimated as Cesario has suggested.

Having read the last paragraph the reader may be asking himself why has the equation appeared with C(1,0), C(2,0) and now there is reference to K. The reason is that what could be called the "absolute" A( )'s and E( )'s which appear in Equation 10 are not what are estimated by Cesario. Because there is a problem in knowing on what "absolute" scale to measure attractiveness of a park or city emissiveness, these are measured on relative scales so that if AA(d) and EE(o) are the estimates obtained:

A(d) = some constant times AA(d) = K(1)AA(d)

E(o) = some constant times EE(o) = K(2)EE(o)

Actually, both AA(d)'s and EE(o)'s are estimated in such a way that the product of all AA(d)'s equals one and the same applies to the EE(o)'s. This constraint or some similar one is necessary if one is to be able to get estimates (e.g. see Reference 29).

Now, the K(1) and K(2) introduced are critical in understanding other estimation problems. The constant estimated in the regression, K, is, as can be seen below, a number that reflects the values of both K(1) and K(2). The relation that shows this is:

$$
\begin{aligned}
V(o.d) &= F(D(o,d))\ K(1)AA(d)\ K(2)\ EE(o) \\
&= KF(D(o,d))\ AA(d)\ EE(o)
\end{aligned}
$$

Without information to define K(1) or K(2) the other component of the estimated K cannot be determined.

Given the preceding considerations the estimation procedure endorsed here for obtaining the parameters of the generalized Cesario model is essentially the same two step procedure proposed by Cesario. However, there are complications which arise because of the SE and SM parameters. Regardless, the first stage estimation is by the analysis of covariance (see TN 4), to produce estimates of K, r the A(d)'s and E(o)'s.

In the second step of estimation the emissivities of the Cesario formulation become the focus of attention. One might think that he has the information shown in Figure 2, which appears to show M times N observations to be used in estimating M + 3 parameters: the CG(o)'s, K(2), SE and SM in Equation 4 below.

$$
\begin{aligned}
(4)\quad EE(o) &= E(o)/K(2) \\
&= (1/K(2))\ CG(o)\ POP(o) * \\
&\quad (PP(o)/\ @E\ P(o,d)) * \\
&\quad (\ @E\ (P(o,d)/PP(o))**SE)**SM
\end{aligned}
$$

But now it is necessary to consider whether the equation for which parameters are to be determined is identified: whether it is mathematically possible to determine unique parameter estimates. For the original Equation 4 there are M blocks of N equations each as shown in Figure 2. Thus it appears that M + 3 parameters are to be estimated from around M x N observations. But consider taking the natural logarithms of both sides of Equation 4 and moving all known terms to the left-hand side. Then one has:

$$
\begin{aligned}
(5)\quad DD(o) &= SM\ \ln\ (\ @E\ (P(o,d)/PP(o))**SE)\ + \\
&\quad \ln\ CG(o) + \ln\ 1/K(2))
\end{aligned}
$$

WHERE DD(o) is the sum of all known terms or one writes

$$
\begin{aligned}
(6)\quad DD(o) &= SM\ \ln\ (\ @E\ (P(o,d)/PP(o))**SE)\ + \\
&\quad U(o) + KK(2) + \mathcal{E}(o)
\end{aligned}
$$

FIGURE 2

THE RELATION BETWEEN E( )'s
AND THE DATA FROM WHICH
THEY CAN BE ESTIMATED

Block 1: $\left.\begin{array}{lcr} V(1,1) = \ldots & & A(1)E(1) \\ \cdot & & \\ \cdot & & \\ \cdot & & \\ V(1,N) = \ldots & & A(N)E(1) \end{array}\right|$ N Equations

Block 2: $\left.\begin{array}{lcr} V(2,1) = \ldots & & A(1)E(2) \\ \cdot & & \\ \cdot & & \\ \cdot & & \\ V(2,N) = \ldots & & A(N)E(2) \end{array}\right|$ N Equations

Block M: $\left.\begin{array}{lcr} V(M,1) = \ldots & & A(1)E(M) \\ \cdot & & \\ \cdot & & \\ \cdot & & \\ V(M,N) = \ldots & & A(N)E(M) \end{array}\right|$ N Equations

<><><><><>

WHERE U(o) = ln CG(o), KK(2) = ln (1/K(2)) and $\mathcal{E}$(o) reflects the presence of error.

So, when one moves to estimation of Equation 5, it can be seen that each of the M blocks in Figure 2 contains equations which could be transformed using first estimation cycle estimates to give equations like Equation 6. Each block essentially contains different observations of the same true value of DD(o) as a function of SE, SM, KK(2) and the U(o)'s. Thus one can see that E(1) or equivalently DD(1) is common to all equations in block 1 of Figure 2, E(2) is common to all equations of block 2 etc.

So, one might as well only use the M estimated E(o)'s, the EE(o)'s, as the dependent variables, in order to estimate the unknown parameters for all origins. The unknown parameters are as just indicated SE, SM, K(2), and the U(o)'s or in terms of Equation 5 they are SE, SM, K(2), and the CG(o)'s. Regardless, as already stressed there are M + 3 parameters to be estimated. Now, even though the EE(o)'s were such that @E ln EE(o) = 0 and thus have M-1 degrees of freedom, the DD(o)'s which are the dependent variable in Equation 6 do not satisfy the same linear constraint and can be considered to be M pieces of information allowing M parameters to be estimated. But it has been suggested that M + 3 parameters are to estimated. From M observation this is

not possible unless something is done.

Firstly, in proceeding to obtain estimates it is necessary to recognize that if KK(2) and G(o)'s are considered in the same analysis of variance, in the way that Cesario computed a constant and city effects, a constraint must be placed on the G(o)'s to remove a linear relation between them and the "mean term" KK(2). So consider that the constraint is applied so that the estimated U(o)'s have a sum of zero. Then there are M + 2 parameters to estimate. But applying the constraint is an indication that it is not the absolute CG(o)'s, or in logarithmic form absolute U(o)'s that are being estimated but:

(7) $UU(o) = K(3)\ U(o)$

So, also one sees that one will not get an estimate of ln K(2) but K(3) ln K(2).

Still with the constraint on the U(o)'s there are two too many parameters to be estimated. So the problem is how to get estimates. One way is to eliminate the need to estimate two of the U(o)'s. One basis for doing this is to say that some cities are so similar that they are accepted as having the same U(o)'s. For example one may assume that U(i)=U(j) and U(k)=U(r) where i,j,k and r indicate at least 3 different origins (i could equal k).

Estimation in which the strategy just described was used to achieve estimates of parameters was tested using a special non-linear estimation program. This is commented on in the discussion section of the paper.

As long as only M-3 U(o)'s are introduced one can estimate the G(o) up to a multiplicative constant. Still, the ln CG(o) = U(o) are not the ultimate object of interest. The planner or researcher ultimately wants to be able to explain U(o)'s or the corresponding CG(o)'s by observable information (e.g. socio-economic). Viewed in this way one can see why there need not be interest in estimates of the M-3 CG(o)'s but there should be interest in parameters that show how CG(o)'s for cities relate to socio-economic information about the residents of the cities.

A second alternative can in fact be pursued which is analogous to Cesario Stage II estimation. If one accepts that the U(o)'s in Equation 6 can be written as:

(8) $U(o) = \ln(AE(o)/POP(o))$

WHERE by Equation 2C

(9) $AE(o) = C(2,o)\ (UN(o) + @E\ B(i,j)n(i,j))$

Taking UN(o) out of the sum and using the Taylor series expansion of the natural log (1 + X) being approximately X for X much less than one one has:

(10) $U(o) = -\ln POP(o) + \ln N(o) + \ln(C(2,o)U) +$

ln(1 + @E (B(i,j)n(i,j))/UN(o))

(11) U(o) equiv ln(U)+ln(C(2,o))+@E (B(i,j)n(i,j)/(UN(o))

Substituting the approximation for U(o) into Equation 6 one gets the equation for which estimation may be carried out:

(12) DD(o) = SM ln ((@E (P(o,d)/PP(o))**SE) +
KK(2) + ln(U) + ln(C(2,o)) +
@E (B(i,j) u(i,j)/(UN(o)))

Now, there may be some concern with what was done above because the sum of the (B(i,j)n(i,j))/(UN(o)) might not be small. But, experience in working on TN 16 and TN 12 has shown that the sum will be small. However, if this is a problem there is an alternative formulation where the mean participation rate, y mean, is used instead of U and the sum of concern then is only a correction for a population difference from the average population for which the B(i,j) were estimated. The sum in this alternative formulation given by Equation 17 of TN 6 will only be large in the rare case that a population differs drastically from the population for which the B(i,j) were estimated.

Depending on whether or not the U and B(i,j) are to be treated as parameters to be estimated or known values used to arrive at an equation in which SE, SM, KK(2) and C(2,o)'s are the unknowns, there will be different matters of concern. If the B(i,j)'s are to be estimated, it is reasonable to follow the strategy that Cesario implicitly did in his emissiveness analysis of considering C(2,o) = a constant for all o. Then, one need only be concerned that M-3 of the B(i,j)'s can be estimated along with (1) a constant that has a value dependent on ln C(2,o), ln U and KK(2); (2) SE; and (3) SM. On the other hand if U and B(i,j) values are determined exogenously and are used along with known n(i,j) and N(o) to make a correction for population distribution, one has the problem discussed earlier with respect to estimating the CG(o)'s or their logs, the U(o)'s. As indicated in that discussion, identification can be achieved by specifying that C(2,i) = C(2,j) and C(2,k) = C(2,r) while the C(2,o)'s are transformed in scale by applying the estimation constraint that the sum of the estimated ln (C(2,o)) must equal zero.

RESULTS AND DISCUSSION

The model proposed here preserves the elements of the Cesario approach, but extends it to include an alternative factor and other parameters to "explain" how people respond to change in supply.

There was no question that the "Stage I" emissiveness and attractiveness parameters could be estimated. But there was enough concern about whether Stage II estimation would

be successful that the estimation test alluded to earlier was carried out. A simple example estimation was run using a two park, five city system with sufficient constraints on the CG(o) so that the parameters in Equation 5 were identifiable. The values of the dependent variable DD(o) of Equation 6 were computed based on "correct" values for SM, SE, KK(2) and the CG(o). In practice, of course, the DD(o) would have a stochastic element but concern was not with the sensitivity of the parameters to error in DD(o). Using the predetermined DD(o) as dependent variables and an assumed initial value of SE, Equation 5 was estimated by an iterative least squares regression.

The iterative procedure used is straighforward. After assuming an initial value for SE, SM and the U(o)'s were computed by linear regression. The initial value of SE was then corrected according to a "gradient" criterion which moved the first estimate of SE towards the value which minimizes the sum of squared residuals. This new value of SE was used in a second step to produce new values of SM and the U(o)'s; SE was again re-computed, and so on, until "convergence" to a minimum sum of squared residuals. The principles involved were essentially those on which PLEAS is based.

After 3 - 5 iterations in a variety of different tests, for different initial values of SE, the original assumed values of parameters were recovered. Thus it was shown that the structure is such that the model is estimable leading to a unique solution, at least for the particular case considered and when the kinds of assumptions specified earlier can be made.

Certainly, it is possible to specify parameter values for which estimation cannot be carried out (SE = SM = 1). But except for this rather unlikely case, and possibly some others like it, it is not to be expected that estimation problems will arise except when the "DD(o)'s + error" are so variable that no "reasonable" parameter values will explain them.

Thus what is proposed in this paper is a modification of the Cesario estimation approach that allows one to take into account people's response to alternative parks that they can visit that are around them. In this model one explicitly recognizes that the emissiveness estimated in Cesario's first step of estimation should not be analyzed without considering the configuration of supply around a city. The formulation is such that one has an explicit function defined which allows one to take into account the attractivity of alternative destinations and their geographic configuration, when one wants to calculate what will happen when a new park is added to a system or an existing park is removed. Actually a similar operation can be carried out using the model introduced in TN 1. There Cheung even presents an example of how a system is altered when a new park is introduced. He has computed new origin destination flows based on changing his alternative factor. Incidentally Cheung's alternative factor has much in common

with the alternative factor derived here and others that have been defined (see TN 30 and TN 3).

The reader may wish to note that originally the degeneracy problem encountered in Stage II estimation (which was described in the Estimation section of the paper) was not recognized. When Bacon (see Reference 3) worked on the problem origin-destination flows were generated and in Stage II estimation with 1300 flows no answer was found as to why attempts to estimate 27 parameters for 26 cities always failed because matrices which were to be inverted to estimate the parameters were of rank 25 or less. It was not obvious that with all the origin-destination flows one really only had 26 "independent" pieces of information on which to estimate parameters.

It is not being suggested that the model defined gives a better fit to data than the Cesario model. Obviously the fit to given data is determined by the first cycle of estimation. What is claimed is that the second cycle of estimation results in inherent emissiveness values should not be used in making estimates of what will happen if a system of parks is changed. Cesario's attempt to estimate the relationship of his emissiveness values to the aggregate socio-economic characteristics was not successful. This is probably because more variance is associated with the alternative factor component of Cesario's E's than with the inherent emissiveness factors, the CG(o)'s, which depend on socio-economic characteristics.

It would be quite possible to take a given system of parks and carry out a simulation exercise based on parameter estimates to find out how much of the variation in the Stage I emissiveness is related to the configuration of parks around the origins considered, and how much is related to socio-economic characteristics of the inhabitants of these origins. Simulations along this line have shown that once size of population has been considered, variation from other socio-economic characteristics may be expected to produce no more than about 5 to 10 percent difference in the amount of participation the different cities will generate. (CG's do not vary much but C(2,o)'s may). The point is that the configuration of parks around cities may account for a much larger variation in the amount of participation that cities will generate than do socio-economic variables.

In practical terms the last paragraph indicates that the spread of the EE(o) values about the line shown is to be expected. It is to be expected because the distribution of supply around various cities is affecting the values that EE(o)'s have as well as these being influenced by N(o) and differences in the socio-economic characteristics of cities.

These authors believe that in terms of the model presented, the important research step that must be taken is not the consideration of the effect of income or other variables on EE(o)'s which is what Cesario suggested (see TN 4), but the identification of the influence of supply on EE(o)'s and then consideration of the importance of C(2,o) or C(1,o) factors of city uniqueness in explaining

behaviour.

It would be nice to be able to report that computer runs have been made using the data which Cesario used that confirm the validity of "The Generalized Cesario Model". However, this is NOT EXACTLY the case. Weighted regression runs (TN 19) to estimate more accurate emissiveness parameters than those presented in TN 4 have been processed. The E( )'s obtained have been analyzed to determine if they are in accord with the formulation for an origin.

E( ) is equivalent to K (Prorating ratio) *
(supply generates demand effect) *
(Population)

E( ) is equal to K X(2,o)(X(3,o)**SM)POP(o)

Actually, it was convenient to determine if the prorating ratio and population have an exponent of one. Because, as indicated above, the supply generates demand effect has an exponent SM, this was estimated. The results were that Cesario's emissiveness values were not compatible with the generalization in the Note, but rather with the generalization in which SE is less than one, not greater than one, and in which the maximum potential to visit a park, from PP(o), is an important variable. One model developed had a R^2 of 0.80 when population alone was introduced. When the other two variables were included R^2 was 0.95. When these other two variables (PP(o) and X(3,o) with SE < 1) were introduced, each alone, (given the other and population) had already explained a significant amount of variance. However, this model is not discussed because its definition and the rationale behind it, would be a deviation from the theme of this paper. It is planned to present these results in a separate non-CORD Study paper.

Nevertheless, the results of estimating parameters for SE = 1.2 and 1.4 were invalid, because of the collinearity between X(2,o) and X(3,o). The correlation for SE = 1.2 was 0.985, while the correlation for SE = 1.4 was 0.955. To obtain estimates of parameters, either X(2,o) or X(3,o) was eliminated from the equation. When this was done, it was found that the coefficients B(2) and (-B(3)) did not have values between zero and one. That was to be expected because B(2) should be one and X(2,o) and X(3,o) have about the same variance and negative correlation. Therefore, 1 > B(3) > 0. This means that if B(2) is estimated, it should be TOO SMALL by the value of SM; and if SM is estimated it should be TOO SMALL by -1, because its value will include -B(2). Actually, B(2) values were in the -2 range, and B(3) values were in the +2 range. Population had the coefficient of 1.07 (as determined by Cesario).

The values of B(2) and B(3) suggest that the structure of the particular Generalized Cesario Model used was not appropriate to the data. Because the two regression coefficients relating emissiveness to X(2,o) and X(3,o) were too large, it seems clear that:

1. being located in park-like land, there was not much need to use "park-influenced emissiveness"; and

2. the "configuration" of parks around a city reflect: a)a history of trying to meet needs, or b)little need to meet needs because of a situation such as that suggested in 1.

The regression results with the highest R^2 values show the plausibility of these latter hypotheses. In the preceding equation for X(3,o), when one lets SE be less than 1, the number of parks with much potential are parks which would be used if others are full, etc. is emphasized. Introducing the highest potential PP(o) as a variable serves as a means of identifying origins in high quality park country other than by X(3,o) which can have contradictory meaning because potentials are normalized to a PP(o). This can be poor for the best of parks.

In particular, it can be seen from the comments on B(2,o) and B(3,o), that the values are not in the ranges suggested! Still, as the results indicate the regression coefficients are highly significant and explain highly significant amounts of variance.

The kind of research suggested above has not proceeded beyond the stage just described because as work on TN 19 and TN 35 progressed it became clear that it was necessary to use weighted regression to get more accurate estimates of the EE(o)'s than originally obtained by Cesario. These were obtained late in 1974. However, getting the new estimates of the EE(o)'s, which were much more accurate than ordinary least squares estimates, only raised a new problem and that was that the Cesario model should be rejected as structurally invalid for the analysis of the data to which it was being applied. Certain obvious problems with the data used include (1) using combined data for week day, weekend days and holidays (see TN 8) and (2) problems in defining if a visitor was really a main destination visitor (see TN 30). Also there is a problem commented on subsequently in that in the Cesario data are only data on part of the parks in a system.

In summary, recognizing the problems already cited meant that EE(o)'s and park attractivities estimated by Cesario might not have clear meanings. Thus further sophisticated analysis of the EE(o)'s was not justified. Ideally a new analysis will be carried out on a new large data set on a truly complete system of parks and with good definitions and data collection practices being used in assembling these data (see TN 21 and Volumes I and II for details on the problems with CORD Study Park User Surveys). Then, one will be justified in more elaborate empirical analyses of the EE(o)'s than that presented earlier.

However, the proceeding discussion evades the issue of how appropriate the Cesario model is to data to which it has been applied. Empirical results have been derived. Applying the Cesario model to estimate parameters that explain visitor flows for Ontario (TN 4) and then using the results

to simulate origin-destination flows has shown that whereas the Cesario model (when used with real data) results in an R-squared in the order of .8, it should result in a much higher R-squared, as indicated by the R-squared values obtained when estimating parameters for simulated Ontario visitor flows. For the Ontario Parks on which estimation was originally done, parameter estimation on simulated data for Ontario Parks showed that the R-squared for estimation should be in excess of .99. The "generalization" suggested may explain part of the variance not explained by the relation between population and emissiveness, but it does not explain any of the 20% of variance which was left unexplained after the Cesario model was applied. This obvious failure in terms of explanation points up the structural deficiency of the Cesario model (for tests of such models structure see TN 19 and TN 35).

One may reasonably ask what could be wrong with a model as general as the Cesario model. A simple answer is that the model does not allow for asymmetries in behaviour. The kind of situation which might be creating problems is shown in Figure 3, where people do not go to a given park from a certain city because it is readily available as supply to other locations. People in city 3 have a park which from their perspective appears more attractive than park A which appears attractive to city 1 and 2. In particular the other source of problems, as suggested earlier, is almost certainly aggregation over different types of use (see TN 3, TN 8 and TN 40, etc.) Obviously if the data on camping combines continuous users or holiday users with weekend users different functions should be used to explain the behaviour of these people. It is not enough to simply deal with campers.

At this point it remains unknown whether introducing this further consideration would result in a drastic improvement in the R-squared of the Cesario model but it is these kinds of questions which must be taken up to determine the appropriateness of the Cesario model to sufficiently disaggregated data.

Previous parts of this discussion section have suggested ways of testing the validity of the model proposed here. However, one of the most direct validity tests has not been mentioned. The B(i,j)'s, which can be estimated if it is assumed C(2,o) is equal to a constant for all o's, should agree with the B(i,j)'s obtained by an analysis of variance of national survey information on people's use of parks. CORD Study national survey information provides an abundance of data on parks use and even the similar Canadian Government Travel Bureau surveys provide some data. So if there is success in estimating B(i,j)'s for the Cesario model when it is applied to disaggregated data for which it is more structurally valid than it is for the Ontario data (TN 4), then there is an abundance of "independent" estimates of these B(i,j) so that comparisons can be made resulting in a test of model validity.

Finally, only once in the preceding discussion has the

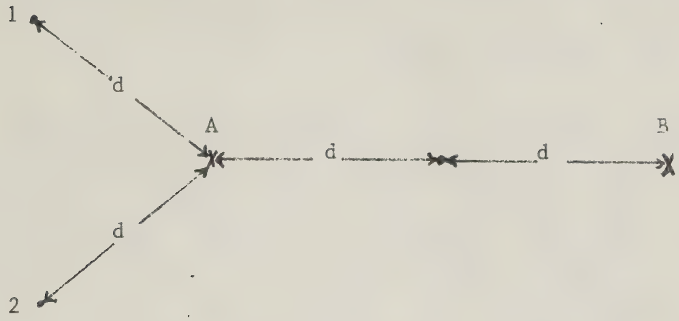

FIGURE 3

THE RELATION OF THREE CITIES TO TWO PARKS THAT ILLUSTRATES A SITUATION

WHERE THE CESARIO MODEL WOULD NOT GIVE GOOD USE ESTIMATES*

Above 1, 2 and 3 are cities, while A and B are parks each with attractivity X.

* It is possible to further generalize the Cesario Model so that the attractivity of A to people from 3 is "corrected" so that it is less attractive than B because of the "competition" effect from cities 1 and 2. This is not discussed here, and it involves major changes to Cesario's original formulation, that have nothing to do with the generalization of the model introduced here.

importance of system definition been introduced. Yet, for Stage II analysis, defining what parks are considered by people from a given origin for a given type of trip on a given type of day (week day, weekend day or holiday) is crucial. With data on any number of origins and destinations one can proceed with Stage I analysis but if one does not have attractivities for all parks affecting use from a given origin then such factors as the following cannot be defined:

SM ln(@E (PP(o)/P(o,d))**SE)

(Actually, except for simulations, one may argue that SE and SM are not system's parameters but should change over time or with changes in supply. This matter is of importance still it is not examined in this paper. A paper must end somewhere.) No more need to be said if specifying "the" system were a simple matter of enumerating certain types of facilities. Unfortunately, the problem of substitutability should be considered for reasons suggested by Veal (see Reference 5) and also discussed in TN 10 and 33 (see also TN 32 and TN 37). Concerns about how the decision to go to a given place is made are elaborated in TN 33 where substitutability is introduced into the Cesario model in two different ways. One has to do with substitution at destinations and attractivity, and the other with substitutability at an origin and emissiveness.

CONCLUSION

The comments of the last few paragraphs show that much of the apparent conceptual elegance of the "generalization" of the Cesario model is counterbalanced by problems that have been ignored or are not dealt with in this paper. Still, the authors believe that the questions raised in this paper and the ways of understanding visitor flows represent useful progress in developing more meaningful models of behaviour.

This paper has shown how the Cesario model can be generalized so that inherent emissiveness can be extracted from the emissiveness parameters that Cesario originally showed how to calculate. This means that if the generalization is even approximately structurally appropriate to a given situation, system model parameters can be calculated which can validly be used in estimating the consequences of, for example, deleting a given park from a system. Cesario's Stage I emissiveness values should not be used because their value is conditional on the system for which parameters are estimated. Thus a critical step in making the Cesario model useful to planners has been taken. It also seems fair to claim that a useful theoretical contribution has been made in clarifying what the emissiveness parameters in the Cesario model really measure in a particular case.

If the paper prompts some other researcher to pursue

research that was suggested it will have served another useful purpose. For example, it seems very important that some research be done to clarify how much Stage I emissiveness depends on supply configuration in a variety of circumstances as opposed to aggregate socio-economic characteristics associated with a city.

Gordon Ewing

The six papers in this section discuss what are commonly referred to as trip distribution models. The models range in complexity from a variant of the most simple gravity model to one which is amongst the most generalised in the present literature.

The first three papers by Cheung et al. involve different elaborations of the simple gravity model. In the simplest, "A Method for Predicting Enroute Overnight Park Use", (TN 18), the form of the basic gravity model, $V(i,j)=k M(i)^{\alpha} M(j)^{\beta}/D(i,j)^{\gamma}$ is retained, but with the terms in the numerator redefined. Where M(i) normally refers to the size of the origin i, it is replaced by T, the volume of traffic on a section of highway leading to j, and M(j), destination size, is redefined as the number of campsites in park j. The other two papers by Cheung replace destination mass, M(j), by a measure of j's attractiveness, T(j), which is exogenously defined as a function of several park characteristics. In addition, a term measuring the strength of competition from alternative destinations completes the modified gravity model. As with the attractiveness terms, the "alternative" term is measured exogenously and simply included in the model as an extra independent variable. The distinction to notice between the other two papers is that "A Day Use Visitation Model" posits that the independent variables, with the exception of distance, are additive in their effect on V(i,j), whilst "An Application of Mathematical Models to Compare Two Potential Park Sites" (TN 7) assumes the same variables combine multiplicatively to affect V(i,j). As is common in trip distribution modelling studies, there is no discussion of the theory that might give rise to these alternative composition rules. Population growth, change in family composition, population "aging", etc. are not considered in TN 7, although it should be.

Whilst the model in Cesario's TN 4 is a variant of the simple gravity model, the innovative feature is that origin emissivity, E(i), and park attractiveness, A(j), now become parameters to be estimated in calibrating the model. The implications of the innovation are important. In calibrating the traditional gravity model with several origin and destination variables, it is never clear whether poor calibration results reflect the absence of important variables or the incorrect structure of the model or some combination. Removing the need to pre-specify the presumed important variables means that poor calibration is more clearly attributable to an improperly structured model.

It also transpires that the ability to estimate E(i) and A(j) values in what appears to be a simple gravity model, $V(i,j) = E(i)A(j)\ f(D(i,j))$, enables these estimates to be used as dependent variables in a second round of parameter estimation in a more complex distribution model.

Evidence for this is to be found in the Beaman et al. paper, TN 11. Indeed, although Cesario's concern is not to calibrate a generalised distribution model, the method he describes clearly provides the impetus for the remaining two papers in this section which involve much more general models.

Both "A Work Plan for the Development of a Mathematical Model to Predict and Explain Overnight Use of Parks" by MacDonald, Netherton and Cesario and TN 11 paper contain terms not found in the other papers. The major difference between the two papers is that the former is concerned only with the formulation of an appropriate mathematical model, whereas Beaman et al. paper consider the mathematical problem of how to estimate parameters in the model. Put simply, the two papers are about the interpretation of emissivity terms as estimated in Cesario's paper. They argue that an origin's emissivity is firstly a function of its size and socio-economic composition. In addition, since E(i) is unique to each origin, they argue that it contains within it an estimate of the spatial supply of facilities which is also unique to any origin. In particular, they see this supply as having two separate and opposite effects. One is referred to as the alternative factor, defined in terms of the sum of all parks' attractivenesses discounted for distance. This is similar to the alternative factor in two of the Cheung et al. papers, except that Cheung had to ignore the effect of alternatives' attractiveness for lack of information. In all cases the size of the alternative factor is seen as having a negative effect on the patronage of any one park, in the sense that these alternatives constitute competition. However, at the same time that all n - 1 alternatives provide competition for the nth park, all n parks, and in particular their attractiveness as mediated by distance, can be thought to have a supply-generating-demand effect. That is to say, the more a particular spatially distributed facility is provided, the more use there is likely to be of such facilities. Thus, for example, given a latent demand for cross-country skiing, the more facilities that are provided, the more participation is likely up to a point. TN 11 discusses the problem of separating these two effects embedded in the emissivity term for each origin.

Turning to the individual papers, each has features which merit comment. Cheung's "Day-Use Model", which provided the impetus for many succeeding Techincal Notes, is characteristic of earlier interaction models in that the form of the model is simplified to make statistical estimation straightforward. Thus, unlike later work, the attractiveness of destinations is computed exogenously and weights on the distance terms are determined by trial and error. In particular, the unusual procedure of having three different distance exponents depending on a destination's distance is used. The rationale is that the overall R^2 value in the calibrated model is maximised using these three parameters. However, it is of note that a single exponent for all distances of either 1.5 or 2 results in only a 0.01

reduction in R^2. Statistically it is very probable that the increment of 2 parameters in the model accounts for this small increase, rather than the variable distance exponent having any behavioral significance. This variable exponent on a destination's distance contrasts with the treatment of distances to alternatives which are all assigned an exponent of .5 in the alternative factor. No rationale for this inconsistency is suggested.

Turning to the attractivity factor in the model and in particular to the function used to calculate its value (T(j) = @E (e)S(e) @E (m)R(m)Q(m), its form deserves comment. The relative popularity rating of activity e, S(e), is measured as a direct function of a Canada-wide participation rate in the activity. The importance of facility m(R(m)) in enabling activity e to be enjoyed is calculated from the correlation between a park's attendance and the "amount of" facility m at the park. It would seem that there is an element of "double counting" in the above equation. For example, if horse riding has a low popularity rating (S(e)), it seems likely that horse rental at a park will do little to increase its attendance figures. The latter being the case will produce a low importance rating (R(m)) for horse rental. However R(m) is clearly dependent on S(e) in this case, whereas the implication of the equation is that the terms measure separate and independent factors contributing to park attractiveness.

One other question about the attractivity function is how the "rank" scores (Q(m)) were arrived at for the amounts of certain facilities. For example, why does a 9-hole golf course rate 8.5, and an 18-hole course rate 11, or why 6 showers rate 8 and 8 showers rate 10.5? Why, also, are rank scores then used in calculating T(j) as if they had interval scale properties?

It is noteworthy that the T(j) values calculated contribute one-fifth of one percent to the explained variance of V(i,j), the dependent variable in the model.

As regards the model itself, three points stand out. Firstly, 84% of the 91% of explained variance in V(i,j) is attributable to P(i)/g(D(i,j)), the population of the origin mediated by distance. This dominance of the origin's mass term (population) in interaction models where other non-mass terms are included is a familiar pattern. Indeed it is difficult to cite any published work where origin mass is not the major contributor to the variance explained, along with distance. On the face of it, it might seem that trip distribution modelling is a subject that requires little further investigation, if only 10% or 20% of variance is left unexplained by the simplest gravity model. However, a large value of R^2 in this case depends on there being a large variance of origin mass which produces a large variation in use figures. If an area were studied where origin masses were more uniform, variance attributable to origin mass would be much less. In such a case, R^2 would be greatly reduced if the trip distribution model were not properly specified. In other words, when origin mass has a

large variance, just about any interaction model will give a high R^2 provided origin mass is one of the independent variables. But where the variance of origin mass is small, any but the properly specified interaction model will result in a low R^2 value.

The second feature of the model which is common to most empirical calibrations of interaction models is that the objective function used in estimating parameters is the minimisation of the residual sum of squares of a linear regression model, or in other words the maximisation of R^2. It has been argued elsewhere (see Reference 38) that R^2 is often quite insensitive to significant parameter changes. An example of this in the present paper is given in Table 5. There is only a 3% variation in R^2 as the distance exponent varies between 1.5 and 3 and indeed between 1.5 and 2.5 the range in R^2 is only 1%. Yet these exponents represent a sizeable range in terms of the typical values found in a wide variety of gravity model studies. It has been suggested that whilst R^2 is a valuable measure, it can be used in combination with other measures, such as mean predicted distance. This latter has been found to be much more sensitive to parameter changes. Thus an alternative procedure would be to seek parameter estimates which minimised the difference between mean observed and predicted travel distances, subject to a constraint on the degree that R^2 could deviate from its maximum value.

A third feature of Cheung's interaction model which is unfortunately common to most interaction studies is that no test of the homoscedasticity of the independent variables is provided. The effect of a variable violating this assumption can be to artificially increase R^2. Consider origin population since that is the most important variable contributing to R^2. If, for example, there are many small origins and one or a few very large places, with only a few intermediate sized centres, which is a not uncommon urban size distribution, this distribution is heteroscedastic and will undoubtedly result in an appreciably higher R^2 value than if it was homoscedastic. Although Cheung does not provide information on the size distribution of the origin areas, Table 8 gives a sample of origin area sizes. Fourteen of the fifteen in that table range from 1,000 to 8,000 in population, whilst the fifteenth, Saskatoon, has a population of 117,000. This last value seriously violates the homoscedasticity assumption, and it might have been interesting to calculate R^2 with and without Saskatoon included in the analysis.

One final question relates to the reliability of data based on a 56% voluntary return of completed questionnaires by visitors leaving parks. Whether this group is representative of the universe or of those given the questionnaires on entry to the park is unknown.

Many of the questions addressed to the first paper can obviously be repeated for "An Application of Mathematical Models to Compare Two Potential Park Sites". A very similar equation is calibrated, but no indication of the value of

R^2 is possible. This is a little distressing in that the accuracy of the predictions for the future being made in this paper depend in large part on the accuracy of the model. However, even if R^2 were high, the question of heteroscedasticity still leaves in doubt the reliability of estimated parameters and the validity of the model as structured.

The accuracy of prediction of the future use of parks depends first on the validity of the interaction model and the accurate estimation of its parameters. Secondly, it depends on how accurate estimates of future use levels of parks are. In this paper, the latter are estimated by extrapolating forward figures based on an average of recent years. One obvious question is whether present trends are likely to continue. This depends both on the future rate of population increase remaining steady, particularly amongst the age groups most active in park use, as well as on the future recreational preferences and constraints of the population not changing. The stability of the latter in particular is questionable, although it is difficult to see how changing preferences or constraints and their effects can be reliably predicted. One possible approach, not mentioned by Cheung, would be to calculate whether the rate of change in park use has itself been changing over recent years. For example, a three-year running mean of the change rates in Table 4 might show whether or not the change rate was steady or not.

One final feature of the paper deserving mention is the treatment of site attractiveness. Although park attractiveness is not part of the model (for reasons explained by Cheung), a method is used to estimate the attractiveness of two existing sites and this is then used as a surrogate for the projected parks, prediction of whose future use is the goal of the paper. However, the grounds on which the parallel is drawn between the two existing and future sites are not indicated. In general, two alternative methods exist for estimating the attractiveness of an as yet non-existent park. One, (possibly rare) procedure would be to do as Cheung did and find an existing park whose characteristics were close to those of the proposed park, both in quantity and quality. The other park attractiveness to a set of measurable park characteristics, so that only a knowledge of the latter quantities in any future park would be necessary to accurately define its attractiveness.

In "A Method for Predicting Enroute Overnight Park Use", a high R^2 is obtained after a logarithmic transformation of the data and is not a measure of goodness of fit between the untransformed predicted and observed data in table 2. R^2 in the latter is 0.93. Also the percentage error in prediction of the three largest use figures is only about 8% whereas the mean percentage error for the rest of the data is 21%. This indicates that after logarithmic transformation, the three largest values were much more accurately predicted than the average, which suggests that even after logarithmic transformation the homoscedasticity

assumption is still not met.

It is interesting to note that origin size, in the form of traffic volume on the nearest arterial highway, and distance to that highway explain relatively little variance in enroute camper volume compared to campsite capacity. It is rare indeed to find either the origin or destination mass term not contributing a large amount to the variance explained. However, the fact that distance contributed so little to the variance explained might provide a clue as to why highway traffic volume also explained very little, vis-a-vis campsite capacity. It is most improbable that distance, per se, has little effect on patronage: so many recreation studies indicate otherwise. However, if the range of campsite-to-highway distances is quite narrow it is possible that, since people are not infinitely sensitive to distance, the differences in distance are not large enough to have any appreciable effect on patronage. Likewise, if the range of highway traffic volumes (or at least camper traffic volumes) is small, they may give the appearance of having little influence on campsite attendance, even though a larger range of values might show them contributing appreciably to R^2. Since the original data are not provided in the paper, the latter must remain speculative. However, if the regression results are taken at face value, and there is assumed to be appreciable variation in highway traffic volumes and distances, the appropriate planning response in developing parks to cater to enroute campers would be to give little attention to arterial traffic volume and distance to highway and consider only park size. In other words parks could be located anywhere and only their size would be a consideration, if the results of the regression model were taken at face value. Such an interpretation is so seriously at odds with common sense that one is inclined at least to accept that either arterial traffic volume or distance or both are important, but that this study simply lacks a sufficient range on these variables to measure their effects. Certainly, the rarity of finding either "origin mass" or distance to be of relatively minor importance in explaining visitation levels is such that the findings should not readily be accepted without further enquiry.

Cesario's paper breaks new ground in trip distribution studies for reasons stated earlier in this review. The paper also should be seen as part of a continuing series of papers by Cesario on this topic (see Reference 9). In this regard, it should be noted that his paper in the Journal of Regional Science, January, 1974, describes a solution to the problem of biassed parameter estimates which he indicated to be in progress in his recommendation No. 4.

Basically Cesario's analysis of convariance model is used to estimate one set of parameters ($E(i)$, $i = 1, 2, \ldots, n$) which are unique to each origin and another set ($A(j)$, $j = 1, 2, \ldots, m$) which are unique to each destination. The major area of debate relates to the interpretation of these parameters. Cesario's opinion in this paper appears to be that "the emissiveness of population centre i, $E(i)$,

reflects its relative (to other population centers) propensity to emit trips under identical circumstances - that is, if it were the case that all centres were confronted by the same availability or "supply" of recreation opportunities". He provides no rationalisation of this assertion. In contrast, the paper by Beaman interpretes E(i) more generally as a composite measure of several factors unique to origin i, one of which is its unique spatial supply of park facilities. It is, of course, unique in that no other origin has the same spatial relationship to the set of parks under study. This latter, broader interpretation of E(i) would seem to be the more defensible one at the present stage of knowledge, until such time as empirical evidence is provided to show that the spatial supply effect is negligible.

Cesario's interpretation of attractiveness of park j, A(j), is that it "reflects its relative (to other parks) ability to attract trips under identical circumstances - e.g., if it were the case that all parks were equally accessible from each population centre". Since the effect of distance between i and j is separated out in the model, it is certainly acceptable to define "identical circumstances" as all parks being equally accessible from centre i. However, in a vein similar to the argument about emissiveness, the reader may be inclined to suggest that contained within A(j) is the competition which park j faces from the other parks. However, the competition which park j faces varies with the origin i from which it is being evaluated and is a constant for all parks as viewed from origin i. Therefore the competition effect can properly be assigned to the origin rather than the destination. In other words, E(i) may contain a combined "supply of and competition of alternatives" effect. This appears most clearly in the MacDonald et al. paper (see TN 30) in their model where:

$$(1)\ V(i,j)=k\ S(i)\ast\ast\alpha\ P(i)\ast\ast\beta\ (\ \partial E\ A(k)/C(i,k)\ast\ast\gamma)\ast\ast\phi\ \ast$$
$$(A(j)\ /C(i,j)\ast\ast\gamma)\ /\ (\ \partial E\ A(k)/C(i,j)\ast\ast\gamma$$

(all summations in Equations 1 through 3 are over m),

In this expression

$(\ \partial E\ A(k)\ /C(i,j)\ast\ast\gamma)\ast\ast\phi$
refers to the supply-generating-demand effect, while

$1/\ \partial E\ A(k)\ /C(i,j)\ast\ast\gamma$

refers to j's competition from all parks as measured from centre i. Clearly both expressions are unique to origin i and therefore can be thought of as being contained in E(i) along with $S(i)\ast\ast\alpha$ and $P(i)\ast\ast\beta$, so that the above equation could be rewritten in a form similar to Cesario's (see Equation 2 below in this review) with E(i) defined as in Equation 3 of this review.

The suggestion by Cesario (unpublished) that k in his Equation 5 can be taken to implicitly refer to the "competing opportunity" effect is clearly incorrect, if the level of spatial competition varies with the location of the origin with respect to the competing parks. If the latter is true, then the competition effect varies with origin i, and is presumably contained in the estimate of E(i).

In the second stage of his analysis, Cesario seeks to explain the estimates obtained for all E(i) and A(j) values. A regression analysis shows 77% of the variance in E(i) values to be accounted for by origin population. The fact that origin mass terms are very important in "explaining" trip flows is well documented in many gravity model studies. Cesario suggests that so great is the contribution of population that it is not worth trying to refine the predictive equation by including other variables or using different functional forms. The counterargument is that so long as absolute flows are used as the dependent variable in a trip distribution study, origin mass, be it population, manufactured goods or whatever, will inevitable account for a large proportion of trip flow variance. The relation is almost as inevitable as the results of a regression study showing that the variance in the number of deaths in population centres is largely explained by their population size. Both beg a question. In the latter, the concern should presumably be to explain variance in the mortality rate of certain age groups rather than absolute mortality figures. And in trip distribution studies, the concern should surely be to explain variance in the per capita rate of flow between origins and destinations. Explaining absolute flows and emissiveness would appear in general to be a fairly trivial problem; explaining flow and emissiveness rates almost certainly is not. The dependent variable in this case would be V(i,j)/P(i). The more subtle possible influences of socioeconomic variables which are dwarfed in the present study by the effect of P(i) on V(i,j) and E(i) would have a chance to be revealed, if indeed they have an effect on the emissivity rate. Another independent variable which might well be included in an analysis of emissivity rates is:

(@E A(k) /C(i,k)**γ)**ø-1

which incorporates both the origin specific supply-generating demand and competition effects defined in Equation 1 above.

Despite the above comments, the paper marks a significant methodological advance in the trip distribution literature. It was the first to estimate values of A(i) and E(j) independent of ad hoc assumptions about relevant variables. And from it useful progress in trip distribution analysis has been made, as exemplified by the two remaining papers in this section by MacDonald et al., and Beaman, to which we now turn.

"A Work Plan for the Development of a Mathematical Model to Predict and Explain Overnight Use of Parks" by

MacDonald et al. is generically similar to the model discussed in the last paper of this section by Beaman. Both are significant extensions of the model discussed in Cesario's paper, although estimation of parameters in the former two depends on an initial estimation of attractiveness and emissivity parameters using the analysis of covariance method described in Cesario's paper. Although parameter estimation is not discussed in the paper by MacDonald et al., Equation 9 could be rewritten as:

(2) V(i,j) = E(i) A(j) /C(i,j)**γ

WHERE E(i), i = 1, 2, ..., n and A(j), j = 1, 2, ..., m and γ are parameters to be empirically estimated by the method discussed in Cesario's paper, and E(i) is defined as

(3) E(i)=k S(i)**α P(i)**β (@E A(k)/C(i,k)**γ)**ø-1

Given estimates of E(i) and A(j), the latter equation can be solved for values of α, β, γ and ø.

Unlike the Cheung models where attractiveness is estimated by a predetermined function of specified site variables, attractiveness in the MacDonald et al., Cesario and Beaman et al. papers, it is empirically estimable from trip distribution data. In addition, the distance exponent is estimated by a least squares minimising routine, rather than by the trial and error method used by Cheung.

MacDonald et al. include in their model 1 a supply-generating-demand effect defined as a non-linear function of the sum of all parks' attractiveness/distance ratios. In model 2, this term is replaced by one defining the probability of a potential camper from i visiting any of the parks at all. The theoretical underpinnings and derivation of this probability term are much stronger than for the equivalent term in model 1. However, the derivation of this probability relies on the rather strong, and in this case, doubtful assumption that the probability of visiting any particular park from origin i is independent of the probability of visiting any other park. It would seem more likely that the higher the probability of one park being visited, the lower the probability of another being visited, in which case the probabilities would not be independent (but see TN 19). The consequences of not conforming to this assumption deserve to explored before it is used to define one of the terms of model 2.

With specific regard to the enroute model, which is a special case of the main destination model, the discussion does not make clear what the definition is of alternative parks for an enroute stop. If the definition were all parks as viewed from a particular link on the highway network, C(i,j) would only reasonably be defined as the distance between park j and the nearest point on an arterial highway for parks on that link. For all other parks, C(i,j) would be the arterial distance plus side-road distance between link i and park j. If only parks adjacent to link i are considered

as alternatives, then the definition of C(i,j) given in the paper is reasonable. It also bears emphasis that the enroute camper model assumes that on all links the percentage of campers who are looking for an overnight stopping place is a constant.

An issue raised indirectly in the MacDonald et al. paper is that no model exists to predict touring camper choices. It seems probable that many vacation campers have regions rather than sites as destinations, and although the task of modelling spatial choice that involves (first) a region and (second) a route and stopping places may seem formidable, the prediction of park use levels may depend on such a model to an appreciable extent.

Many of the features of the model have already been commented on with respect to the paper by MacDonald et al. The basic issue involved in the Beaman et al. model is to define a model which is valid for any number of destinations, including a single destination. At the same time the model requires the two features discussed earlier, the supply-generating-demand effect of destinations and their competition effect. Beaman et al. try to satisfy these conditions in Equation 3 which simplifies to Equation 2 in the special case of the single destination, or isolated site as it is described in the paper. The expressions in Equation 3 that may be least familiar to the reader are also those that simplify to the value 1 when there is only one destination. Specifically they are, PP(o)/ @E P(o,d) which refers to the "competition from alternatives" effect and @E (P(o,d)/PP(o))**SE)**SM, which refers to the "supply generating demand" effect. The justification for the first expression, which is not completely clear from the text, is that the denominator is a measure of competition defined in terms of the sum of all sites' attractiveness/distance ratios, identical to the denominator of Equation 9 and 10 of MacDonald et al.'s paper. The numerator which is simply a constant for any one origin is required for the isolated site case in which the numerator and denominator become identical and cancel each other. The justification for the second expression is as follows. The exponent SM is required to define the positive non-linear effect of supply on use, but must be less than or equal to 1, to satisfy an earlier condition in the paper that with more than one site, total visitation will exceed visitation to a single one of these sites but will be less than the sum of visitations to each site, if each were the only site.

In passing, the latter part of this condition seems unnecessarily rigid. It seems possible that the sum of visits to, say, two sites might exceed the visitation they would receive if each were an isolated site. In any event, relaxation of the assumption would simply entail setting no limits on the value of SM. SE can be interpreted behaviorally as implying that sites with a smaller attractiveness/ distance ratio contribute even less to the supply-generating-demand effect than their relative size would suggest. Once again this assumption could be readily

relaxed without any change to the structure of the expression. The reason for PP(o) in the denominator is to ensure that one of the terms in the summation will always equal 1, so that the summation will always be greater than 1 for the case of two or more sites, and equal 1 exactly for the case of the isolated site, no matter what values SE and SM take on. This satisfies the basic assumption that there will be extra demand stimulated by the provision of an extra site, as well as the assumption that the supply generating demand effect is unity in the case of a single site.

Besides the question of solubility (which is not at issue in this paper) the main question that arises is whether or not a more elegant, less complex formulation could achieve the same effect as this model. Certain elements, such as PP(o) in the numerator of the first expression discussed above are disturbing. In the case of PP(o), the effect is to add a different constant to the model for each origin. Without some behavioral interpretation of the role of this term in the general model, its only function seems to be to satisfy conditions for the isolated site model in Equation 2.

However, it is not clear why a simple variant of the more straightforward model proposed by MacDonald et al. (Equation 9 in their paper) would not more simply accomplish all that TN 11 Equation 3 does. Specifically, using TN 11 notation:

(4) V(o,d)=C Pop(O) G(O) (@E (d)P(o,d))**ø *
      (A(d)**[-R(D(o,d))] / @E (d) A(d)**[-R(D(o,d))])

will in the case of the isolated site simplify to:

(5) V(o,d)=C Pop(C) G(O) (A(d)**[-R(D(o,d))])**ø

The difference is that in the isolated site case the supply generating demand effect will vary non-linearly with the value of that site's attractiveness/distance ratio. The two components of Equation 4 can be defined as:

(6) NN(o) = Pop(o) G(o) (@E P(o,d))**ø

WHERE NN(o) = the number of actual park visitors generated by origin o; and

(7) p(o,d)=A(d)**[-R(D(o,d))] / @E (d)**[-R(D(o,d))]

WHERE p(o,d) = the probability of a park visitor from o choosing to visit d from the set of available alternative parks; and by definition the SUM, over o, p(o,d) = 1. In the isolated case, p(o,d) = 1, i.e. all park visitors from o visit d. Therefore, in words, the model estimates the number of park patrons generated from o as a function of o's characteristics as well as of its overall access to parks and then assigns each park d a proportion of o's total visitors based on that park's proportion of the total sum of

parks' attractiveness/ distance ratios.

In any case, the implication is that estimation problems can be overcome, both the Beaman and MacDonald et al. models constitute important efforts to produce a more general and realistic trip distribution model.

ATTRACTIVENESS ANALYSIS

INTRODUCTION

Attractiveness analysis began early in the CORD Study, as did work on visitor flow models, but initially this research was not closely tied to visitor flow modelling: attractivity of a park was treated as an exogeneous variable by Cheung in TN 1. In fact, while the work plan for an overnight-use model was being produced, and while Cesario was making his initial proposal to develop a model, Ross was developing attractivity indices for twelve parks in Saskatchewan. To develop measures giving an ordinal indication of the relative attractiveness of different parks, he proposed a procedure that has been used to analyze the attractiveness of shopping centres. His scheme was accepted and is reported in TN 2.

From the articles in Chapter I, one has not only that Cheung developed attractiveness measures for Saskatchewan parks; the reader will also know that the Cesario modelling effort produced a methodology for calculating park attractiveness. The Cesario model has been used to calculate attractiveness measures for the same Sakatchewan parks for which Cheung and Ross have calculated attractiveness values. So, three different procedures have been used to calculate attractiveness measures for certain Saskatchewan parks. The results achieved are compared in CORD Study TN 9 which raises the question as to whether Cheung, Cesario, and Ross were measuring the same thing. But the matter of how to compare the Cheung, Ross, and Cesario measures of attractivity has been a cause of some controversy. CORD Study TN 28 was developed by Cheung because he felt that a comparison should be made on the basis of the "effectiveness" of various attractiveness measures in models. Cesario has objected to Cheung's use of his measure in models for which it was not designed. He argues that unless his measure can be appropriately transformed for use in other models it should be used only in the type for which it was developed. But this introduction is not the place for discussion: "best", "effectiveness" and "appropriateness" have to do with the proper structuring of models, a problem which is taken up in CORD Study TN 19 and 35 in Chapter VII.

One paper in this chapter, although related to attractive analysis, is not directly related to the other papers. In the years 1971-3, the Planning Division of Parks Canada carried out Wild River Surveys to collect data that would be used to designate rivers with National Park potential. The first methodological report produced (based on data from the 1971 survey) was Quantitative Comparison of

River Landscapes, which described the application of a technique developed by Luna B. Leopold to select wild rivers for designation as National Wild Rivers. Leopold's technique did not focus on perceptions but on determining certain properties of the resource base. This analysis, and other reports about the wild rivers studied, were produced "outside" the CORD Study.

The only CORD Study paper having to do with the Wild River Survey is TN 27, which reports on how data collected in a 1972 Wild River Study have been used to develop predictions of how expert canoeists will perceive the attractiveness of various sites on wild rivers. The major point made in the paper is methodological, nevertheless it is included in this chapter. The paper also has practical implications for campsite design, roadway scenic quality evaluation, and a number of other tasks which involve the evaluation of landscape.

ATTRACTIVITY INDICES

J. H. C Ross

ABSTRACT

In this study, a methodology to estimate the attractivity of parks to a given type of user from data concerning the spatial interactions of individuals who patronize these sites is presented. The model proposed is utilized to produce an ordinal scale defining the relative attractivity of the alternative sites in the system being studied.

The 1969 CORD Study Park User Survey data were used for this analysis. Actually, only information collected at 12 Saskatchewan parks on 3,254 individual trips were used out of a larger data set. Documentation of the data collection and processing is not provided but other sources are cited where this information is available.

Using the data on origin destination flows just referred to, an attractivity ranking of the twelve parks was established. The consistency of the decisions which led to this ranking was found to be significantly non-random, although there is a degree of confusion evident in how different people appeared to rate the parks. Reasons for this confusion are introduced that suggest that much of the confusion is attributable to the nature of the data, and inhomogeneity of user purpose rather than being a result of problems with the methodology.

A postscript contains comments on what kind of research to which the original research has led.

INTRODUCTION

> With all the difficulties involved, it seems entirely possible to develop specific, and rather objective, rating scales for different outdoor recreation areas and for major different uses of each. These scales would have great utility in planning, other research, and administration. The talents and knowledge of different kinds of specialists might well be used in devising and testing such rating scales. (Reference 6)

A general dissatisfaction with the more traditional methods of deriving such scales has led the author to develop an approach which avoids the strong metric assumptions necessary for the derivation of site attraction

scales by the gravity model approach (see Reference 18) yet, at the same time, avoids arbitrarily assigning attraction values solely on the basis of the number and capacity of site facilities. (See References in TN 9 and 16.)

METHODOLOGY

The model of human behavior proposed is concerned with attractiveness, A(j), which is a measure of an inherent property of site j, and distance D(r,j), a measure of the difficulty of travelling from the residence of visitor r to site j. It is assumed that the effects of increasing distance are such that the "degree of impedance" always increases as distance increases – although the function relating impedance and distance need not be defined (see TN 14.) This assumption really means that for any distance D(r,j), travelling further is seen as being more costly and less desirable unless something about the destination reached defrays (compensates for) the extra travel. Wolfe (Reference 24) implies that this assumption is not always valid, but it is accepted here. Now, in one dimensional space, consider an individual residing at point r as shown in Figure 1. The assumptions stated imply that choosing to patronize a site at point 2 means that the site is more attractive than Site 1. If the individual had gone to Site 1 no similar statement could be made about the relative attraction of Site 1 compared to Site 2. For the visitor, distance rather than site attractivity may have been the "force" resulting in visit to 1 rather than some more attractive site.

FIGURE 1

TWO-DIMENSIONAL SPACE

```
          * Site 3



______________________*__________*_________*_____________
                      R       Site 1    Site 2



                                                    *
                                                 Site 4
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The extension of this reasoning to two dimensional space involves assumption that each individual perceives a given distance to be of the same magnitude regardless of the distance he must travel. If this assumption is made one may state that a person implicitly judges the site he selects to be more attractive than any alternative site which is closer to his origin than the selected site. One can make no such judgments with regard to the

relative attraction of sites which are more distant than that which an individual selected. So, in Figure 1, if one accepts that the individual's residence is located at point r, while the points 1 - 4 represent alternative sites, a number of inferences can be made. For example, if the individual chooses to visit Site 4 it can be assumed that he judges that site to be more attractive than any other site closer to his residence.

The Comparison Matrix

Now, if for a number of parties we consider that one individual made the decision to visit a particular site, the number of times that any site i can be inferred to be more attractive than any other site j can be recorded to form a site-by-site compariso matrix C (Figure 2). In this matrix the i,jth entry is the number of times that site i was chosen over site j. In order to prepare such a matrix for further analysis, one must, taking each sample individual in turn, calculate the distance from his residence to each of the alternative sites. Then denoting the site visited as i, C(i,j) is incremented by one for every site j which is closer to the individual's residence than site i.

FIGURE 2

COMPARISON MATRIX: DISTANCE = 200 MILES

Site*	1	2	3	4	5	6	7	8	9	10	11	12
1	0	0	1	61	2	2	1	1	5	8	4	14
2	6	0	3	5	5	5	1	5	7	6	1	21
3	13	4	0	14	47	10	3	10	10	14	3	10
4	11	0	8	0	9	10	4	6	7	19	5	8
5	7	0	9	14	0	2	1	9	1	7	1	6
6	5	0	5	5	8	0	2	4	4	8	2	4
7	42	3	4	10	7	13	0	1	51	44	40	43
8	20	1	2	20	4	1	1	0	2	19	0	18
9	56	2	5	53	50	7	1	43	0	55	0	55
10	203	3	0	227	1	1	1	2	8	0	1	9
11	6	6	1	4	2	5	5	0	146	99	0	5
12	191	1	4	30	6	7	3	7	4	33	4	0

* The names of sites 1 to 12 are given in Table 1.

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The Proportions Matrix

From the comparison matrix C, a proportions matrix P may be determined. The entries in this matrix give the proportion of times that any site i was judged to have a higher attraction than site j. An entry in the P matrix is defined as:

$$P(i,j) = C(i,j)(/C(i,j) + C(j,i))$$

WHERE $P(i,j)$ = the proportion of times site i was chosen over site j,

$C(i,j)$ = the number of times site i was chosen over site j, and

$C(j,i)$ = number of times site j was chosen over site i.

Because situations arise in which site i and site j were never compared, the fact that the comparison is missing must be noted. Throughout this paper, the value -1.00 is used to denote this.

In an ideal situation, when all individuals have similar perceptions as to which sites are most favourable, the elements of P, P(i,j) take only values of 1 and 0. In the real world, however, especially when the sites being compared are very similar in attraction, the value of P(i,j) will be intermediate between 1 and 0.

Psychophysicists, in attempting to derive measurement scales from similar paired comparison matrices, have developed a number of approaches. Many of these are based on the "Law of Comparative Judgment" developed by Thurstone (see Reference 22). If we were to use Thurstone's approach, we would have to assume that each entry in the table could be viewed as a normal deviation from the column mean. But, due to the fact that the individual subject's inferred decision that one site was more attractive than another was conditional on the spatial arrangement of the sites, one cannot regard the P(i,j) as normally distributed variables. Specifically, the large numbers of zeros and ones in the matrix present problems because the probability of getting either under Thurstone's assumptions is infinitely small.

As an alternative approach which avoids these problems, regard any P(i,j) greater than 1/2 as indicating a majority preferring i, and any value less than 1/2 as a majority preference for j. When this is done, one can construct a scale which is consistent with these majority judgments by finding the average value of each row of the P matrix. These values are found by summing the valid entries in each row and dividing by the number of valid entries in that row. The result is defined to be the index of attraction:

$$A(i) = e(i,j)P(i,j)/ \text{@E}\ e(i,j)$$

WHERE $A(i)$ = the attraction index of site i

$P(i,j)$ = the proportion of times site i was chosen over

site j, and

e(i,j) = 1 if P(i,j) is not equal to -1.00, 0 otherwise.

and the sum is on j.

Values of the index of attraction calculated using the matrix presented as Figure 3 are presented as Figure 4.

Index of Confusion

A further measure, the index of confusion, may be calculated. It is defined as the proportion of valid entries in each row of the P matrix which indicate unanimous decisions. The preceeding implies that it is calculated by dividing the number of entries in each row by the number of valid entries in the row, and subtracting the result from 1.0. Values of this index based on the P matrix presented as Figure 3 are shown in Figure 4.

Consistency

Consider three sites, i, j, and k. If A(i) is greater than A(j), and A(j) is greater than A(k), then A(i) must clearly be greater than A(k). Such a triplet is termed a transitive or non-circular triad. The weak transitivity of the P matrix is defined as the degree to which:

IF P(i,j) > .50 and P(j,k) > .50, then P(i,k) > .50 for all i, j, and k.

If the P matrix is incomplete the standard formulae for determining the consistency of the matrix cannot be applied directly. Instead, the n(n-1)(n-2)/6 possible triads must be examined separately. When the P matrix is incomplete, four different outcomes are possible when inspecting a triad. These are:

1. the triad may be non-circular,
2. the triad may be circular or intransitive,
3. the triad may be incomplete but of the form P(i,j) > .5 and P(i,k) > .5,

   - if this is the case it must be transitive, and

4. the triads may be unknown because two elements are absent, (-1 occurs twice).

Kendall's Coefficient of Consistency (see Reference 15) is defined as:

K = 1.0 - (NC/MC)

WHERE NC = the number of circular triads observed, and

FIGURE 3

PROPORTIONS MATRIX: DISTANCE 200 MILES

Site*	1	2	3	4	5	6
1	0.0	0.0	0.07	0.85	0.22	0.29
2	1.00	0.00	0.43	1.00	1.00	1.00
3	0.93	0.57	0.00	0.64	0.84	0.67
4	0.15	0.0	0.36	0.00	0.39	0.67
5	0.78	0.0	0.16	0.61	0.00	0.20
6	0.71	0.0	0.33	0.33	0.80	0.00
7	0.98	0.75	0.57	0.71	0.88	0.87
8	0.95	0.17	0.17	0.77	0.31	0.20
9	0.92	0.22	0.33	0.88	0.98	0.64
10	0.96	0.33	0.0	0.92	0.13	0.11
11	0.60	0.86	0.25	0.44	0.67	0.71
12	0.93	0.05	0.29	0.79	0.50	0.64

Site*	7	8	9	10	11	12
1	0.02	0.05	0.08	0.04	0.40	0.07
2	0.25	0.83	0.78	0.67	0.14	0.95
3	0.43	0.83	0.67	1.00	0.75	0.71
4	0.29	0.23	0.12	0.08	0.56	0.21
5	0.13	0.69	0.02	0.88	0.33	0.50
6	0.13	0.80	0.36	0.89	0.29	0.36
7	0.00	0.50	0.98	0.98	0.89	0.93
8	0.50	0.00	0.04	0.90	-1.00	0.72
9	0.02	0.96	0.00	0.87	0.0	0.93
10	0.02	0.10	0.13	0.00	0.01	0.21
11	0.11	-1.00	1.00	0.99	0.00	0.56
12	0.07	0.28	0.07	0.79	0.44	0.00

* -1.00 indicates a missing value.

NOTE: The names of sites 1 to 12 are given in Table 1.

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MC = the maximum number of circular triads possible.

Reasoning that the maximum degree of inconsistency should be observed judgments between any sites are made at random, the following procedure has been adopted. Create a dummy P matrix's, by replacing all the valid entries below the diagonal with a uniformly distributed random number between

FIGURE 4

REORDERED PROPORTIONS MATRIX

Site*	7	2	3	11	9	8
7	0.00	0.75	0.57	0.89	0.98	0.50
2	0.25	0.00	0.43	0.14	0.78	0.83
3	0.43	0.57	0.00	0.75	0.67	0.83
11	0.11	0.86	0.25	0.00	1.00	-1.00
9	0.02	0.22	0.33	0.0	0.00	0.96
8	0.50	0.17	0.17	-1.00	0.04	0.00
6	0.13	0.0	0.33	0.29	0.36	0.80
12	0.07	0.05	0.29	0.44	0.07	0.28
5	0.13	0.0	0.16	0.33	0.02	0.69
4	0.29	0.0	0.36	0.56	0.12	0.23
10	0.02	0.33	0.0	0.01	0.13	0.10
1	0.02	0.0	0.07	0.40	0.08	0.05

Site*	6	12	5	4	10	1
7	0.87	0.93	0.88	0.71	0.98	0.98
2	1.00	0.95	1.00	1.00	0.67	1.00
3	0.67	0.71	0.84	0.64	1.00	0.93
11	0.71	0.56	0.67	0.44	0.99	0.60
9	0.64	0.93	0.98	0.88	0.87	0.92
8	0.20	0.72	0.31	0.77	0.90	0.95
6	0.00	0.36	0.80	0.33	0.89	0.71
12	0.64	0.00	0.50	0.79	0.79	0.93
5	0.20	0.50	0.00	0.61	0.88	0.78
4	0.67	0.21	0.39	0.00	0.08	0.15
10	0.11	0.21	0.13	0.92	0.00	0.96
1	0.29	0.07	0.22	0.85	0.04	0.0

* (-1.00 indicates a missing value)

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(and including) 1.00 and 0.00. P(i,j)'s above the diagonal are relaced by the complement of the below-diagonal number. That is to say:

P'(i,j) = X, P'(j,i) = 1.00-X

WHFRE P'(i,j) = the i,jth entry in the dummy proportions matrix P', and

X = a uniformly distributed random number between

1.00 and 0.00.

The number of intransitive triads in this dummy matrix is counted and stored. The operation is then repeated, in our case twenty times, and a running sum and sum of squares of the number of circular triads is kept. This allows the mean and standard deviation of the number of circular triads to be calculated. The mean is taken as a guide to the number of intransitive triads which usually occur. The standard deviation allows one to place confidence limits on the difference between this number and the number of circluar triads observed, thus permitting one to text the hypothesis that fewer triads have occurred because there are real site preferences. Verifying whether or not the observed number of triads is significantly less than the number expected by chance is the statistical test endorsed to show that the results of a given analysis show a real preference structure.

Visual Interpretation of the P Matrix

Although the Proportions matrix may be interpreted visually it is helpful to reorder the rows and columns of the matrix in such a way as to place the highest scoring sites at the top and left of the matrix. Figure 4 presents the data of Figure 3 reordered according to high to low site attractiveness as given in Table 1. Ideally, if the matrix were perfectly transitive, and all entries unanimous, all values to the right and above the diagonal would be ones and all to the left and below zeros however, such a situation seldom arises.

Several useful observations can be made from an inspection of the recorded matrix. The inconsistent judgments can be identified as the values greater than .5 below the diagonal, or as values greater than .5 above it. Similarly, the degree of confusion about the attractivity of any site may be readily observed. So, although the display of the P matrix in this fashion adds no new information, it is useful in pinpointing sites which do not appear to fit into the general pattern of the system being studied.

DATA BASE AND PREPARATION

The study was based on Saskatchewan data collected as part of the CORD Study Park User Surveys (see the Data Documentation Volume). The data received by the author were in the form of lists of users at twelve parks in Saskatchewan. Each individual record contained the user's origin and the date he visited the park. These data were tabulated by hand to get origin destination flows. These flow data were then keypunched by punching the code number of each park, the coordinates of each locatable origin from which visits to that park were made and the number of such visits. In summary, the data analyzed consisted of one card

TABLE 1

INDICES OF ATTRACTION AND CONFUSION: 200 MILES

Maximum Distance = 200 Miles

Site	Site Name	Index of Attraction	Index of Confusion
1	Buffalo Pond	.190	.909
2	Cypress Hills	.732	.545
3	Duck Mountain	.730	.909
4	Echo Valley	.277	.909
5	Good Spirit	.390	.909
6	Greenwater	.456	.909
7	Prince Albert	.821	.727
8	Moose Mountain	.473	.900
9	Pike Lake	.614	.727
10	Rowan's Revine	.266	.727
11	Battlefords	.619	.900
12	Besant	.439	.727

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for each origin, each card contained the identity number of the origin, the origin name, its coordinates, and the number of visitors from that origin to each of the twelve parks. (For more detail on the data organization see Reference 25.)

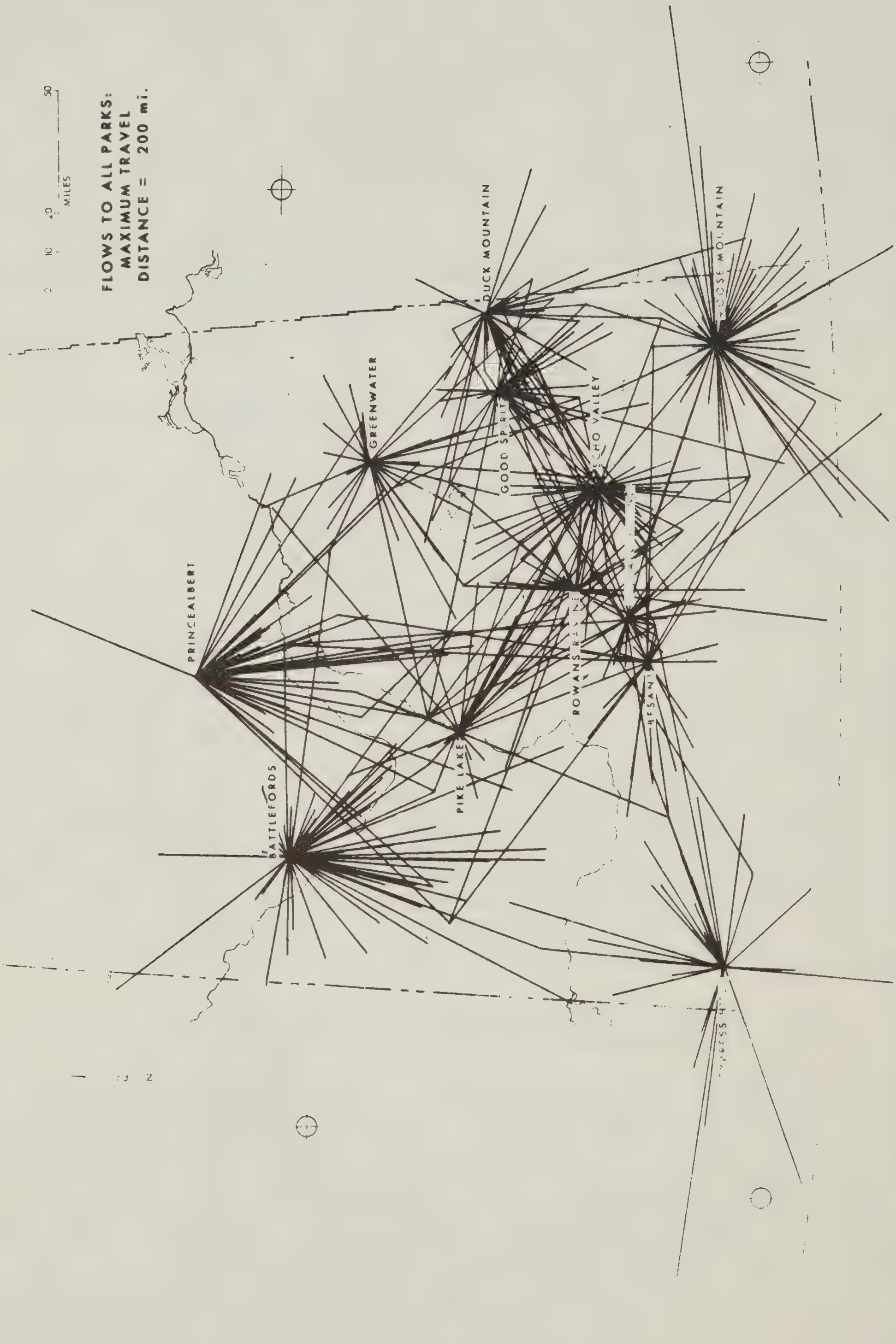
One of the flow patterns actually observed is reproduced as Figure 5. Similar material was prepared for one way travel with upper limits of 220 and 867 miles (for these results see Reference 25). One may find it interesting to note that Figure 5 is based on a total of 3,254 trips.

Results Of The Study

The attractivity indices program was run twice, the first run disallowing any trip exceeding 200 miles in length (one-way), and the second, which is not reported here, omitted those longer than 225 miles. The magnitude of the distance limit imposed is of course arbitrary, but about 200 miles one-way as an upper limit on day trips appears reasonable to the author. Regardless, the imposition of this limit invalidated less than three percent of all trips.

Inspection of the comparison matrix C(introduced earlier in Figure 2) reveals that the number of visitors which may be inferred to have compared any two sites from 0 in the case of Sites 8 and 11 to 241 in the case of Sites 4 and 10. Due to the method of calculating the proportions matrix P (Figure 3) by dividing P(i,j) by P(i,j) + P(j,j)

FIGURE 5
SASKATCHEWAN PARKS



the varying numbers in the cells of the comparison matrix need not prompt undue concern.

It is evident from the proportions matrix P that almost one-third of the entries suggest that users deviate from unanimity by as much as 25% in showing their preferences. This indicates that there is no concensus as to whether one site is more attractive than another. Indeed, only 12 of the 66 comparisons are unanimous. Examination of the confusion indices (see Table 2) indicates that there are differing degrees of confusion for different sites. There is clearly no site about which there is no confusion.

The attraction indices (Table 1) ideally have a range of 1 (for a site which was never judged to be less attractive than any other site) to 0 (for a site which was never judged to be better than any other site). These indices, although regarded as only ordinal in nature, allow one to rank the sites. This was done in Figure 4, using the information from Figure 3. As described earlier, it is in terms of Figure 4 that one may understand a great deal about the preference structure discovered.

It remains to assess the proportions matrix to determine the statistical significance of the results of the analysis. There were 17 circular triads counted, and after 20 simulations the average number of circular triads observed in the randomly generated P matrix was 53, with a standard deviation of 6.09 (this was true with both 200 and 225 mile travel limits). Thus it may be concluded that since the observed number of circular triads was 5.9 standard deviations from the mean, the results obtained were significantly non-random and there was a high degree of agreement between the sample subjects regarding the attraction of sites.

DISCUSSION

Although at present (1971) there is no way of assessing the correctness or accuracy of the results of this study, apart from reviewing the logic of the approach and the accuracy of the computer program used to analyze the data. (This is being written from a 1973 perspective, and a review of the methodology outlined above has been carried out. See TN 9 for details.

It is the authors's opinion that the apparent difficulty of making judgments as to whether one site is more attractive than another (as revealed by the lack of unanimity in the P matrix) is rather disappointing, although if all twelve parks are considered to have similar levels of attractivity it is logical to find a relatively high degree of confusion between them. In a previous study (see Reference 13) eighty percent of the choices resulted in unanimous decisions. However, a great deal of the problem may be traced to the nature of the data set itself. The classification "day-user" may not result in a sufficiently

homogeneous class of users as it includes fishermen, picnickers and swimmers, to name but a few, all of whom may perceive the attractiveness of a particular site differently. Also, in the case of this study, there are many provincial, local, regional and private recreation areas which provide alternate destinations for day trips. No comparable visitation data for these sites was available.

Furthermore, we have no way of knowing whether or not the individuals who visited any given site felt afterwards that the attraction of the site had justified the expense of the trip to it. In other words, the assumption of a well-informed user implicit in most models of recreation behaviour may not be valid. Ideally, this approach is best applied to situations in which it may be assumed that the individual has sufficient knowledge about all the alternative sites closer to his origin than the site he selects to make a rational decision as to which offers the greatest satisfaction – presumably that which he patronizes most often. With the present data one does not have this information, but only knows that a trip was made to a specific site on at least one occasion.

Finally, the question of whether or not the entire benefit the individual receives from his day trip can be attributed to the site he chose to visit is one which has been addressed here.

CONCLUSION

The method employed above to analyze the Saskatchewan day use data has provided a ranking of twelve Saskatchewan parks. The consistency of the decisions which led to this ranking has been found to be significantly non-random, although there is a certain degree of confusion evident in the ordering of the pairwise comparisons. Still, having some behaviourally based attractivity assessment for parks is better than relying on intuition. This is particularly true when it is recognized that possible reasons for the apparent high confusion about various parks' attractivity have been pointed out as probably attributable to the nature of the data. If the conjectures about why the levels of confusion were so high are correct, then the method offers even more promise than is evident from the results achieved.

ATTRACTIVITY INDICES - POSTCRIPT

The main objectives of the attractivity indices model just presented were to determine a unique rank ordering of service sites with respect to their inherent attractions and to establish the degree of consistency present in the individual inferred judgments upon which the ranking is based. Following the establishment of consistent indices of site attraction, investigation of a data set may proceed by either modelling of the spatial choices inferred, or by the

statistical explanation of the "pure" attraction indices which have been revealed. Each of these approaches is discussed below.

<u>The Concept of Preference Surfaces</u>

The concept of preference surfaces is based on the assumptions that an individual in need of a service (in this case recreation) attempts to minimise some function of the attractiveness of each possible alternative and the distance to that alternative, and that each individual faces what may be regarded as a unique array of spatial alternatives. The suggested thought process that each individual employs is a mental search routine whereby each alternative spatial opportunity is compared against all other available opportunities. He then chooses that alternative which will maximise his benefit. If, for example, we postulate a preference function of:

$$U(i,j) = A(j)/D(i,j)$$

WHERE $U(i,j)$ = the net benefit which would accrue to a visitor from origin i who chose to patronize site j,

$A(j)$ = the attraction of site j, and

$D(i,j)$ = the distance between i and j.

We define a preference surface. Such a surface would be similar to that shown in Figure 6. Given such a surface, one can proceed to inspect actual choices made to determine the extent to which the inferred choices were consistent with the postulated surface - that is to say, the proportion of times that any subject i chose to patronize that site j which yielded the highest value of U. One should note that in using a preference surface model it is assumed that a subject will be indifferent to the various spatial opportunities which lie on the same "contour" of the surface, e.g. those opportunities i,j, k,l, and m,n for which U(i,j = U(k,l) =U(m,n).

Initial investigation of the degree to which the observed recreation patterns in the Saskatchewan day use data used to develop the results presented earlier in the paper are explained by various surfaces has been carried out at the University of Western Ontario. Results obtained (based on only the 600 individuals) appear promising. (See Reference 13.)

ESTIMATION OF INFERRED SITE ATTRACTION INDICES FROM OBSERVED SITE CHARACTERISTICS

Various attempts to quantitatively relate the number and quality of facilities to derived attraction indices have

FIGURE 6

HYPOTHETICAL PREFERENCE SURFACE

Height at any point (i,j) = U(i,j) = A/D,
WHERE A = the attraction index of alternative sites;

D = distance to each alternative.

NOTE: The origin of the surface is always located at the individual's home.

An individual would be indifferent to alternatives x and y (because the utility of both is .33), due to the fact that the added attraction of y is compensated for by its greater distance. He would, however, favour z over either x or y. It should also be noted that an individual's disciminatory powers are not perfect, and that each of the infinite number of contours which may be drawn on this surface really represents only the bisector of a zone of indifference.

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been reported in the literature (see the literature review in TN 9). Although several studies have reported a high degree of explanation, the combinatorial rules followed have generally been specific to each data set, thus rendering the formulation of general rules difficult. One of the major problems appears to be that there is little evidence that the supply of facilities and user response to them is a simple, relatively invariant one - although in certain cases (such as that treated by Wennergen and Neilson in Reference 23 in their analysis of demand for fishing) it may very well be the case. In more complex situations it would seem that response to an increased number of any particular type of recreation facilities on one site should be a function of the relative availability of that facility on all alternative sites, and of what a person (party) really wants to do, rather than solely a function of what is at the site in question.

In view of difficulties involved in estimating the influence of increased diversity of facilities on consumers, it is believed that, at this time, the investigation of the relationship between site variables and attraction scores should be approached cautiously, possibly through the use of non-metric techniques. (See TN 4 on the use of metric techniques in recreation analysis problems.)

THREE METHODS FOR MEASURING THE ATTRACTIVENESS OF A PARK - A COMPARISON

J. Beaman

ABSTRACT

Three methodologies designed to measure the attractiveness of outdoor recreation areas are discussed in this paper. The discussion is on the attractiveness of 12 Saskatchewan parks. A good rank correlation agreement between the Ross ordinal measure of attractivity and the Cesario interval measure, but only a weak correlation between Cheung's interval attractivity measure and the other measures is demonstrated.

Regression analysis results indicate that Cesario measured the attractiveness of a site plus possibly what is around it, while Cheung measured only the attractiveness of a particular site. The regression relation derived between the Cheung and Cesario attractivity measure was used to calculate a corrected Cheung measure. But this "corrected" Cheung "destination area attractivity measure" had a lower rank correlation with Cesario's measure than Cheung's uncorrected measure.

The paper ends with the very tentative conclusions that: (1)Ross' and Cesario's indices of attractiveness can reasonably be considered to measure the same thing (though Ross in ordinal and Cesario in interval scale terms); and (2)Cheung measures something different from Ross and Cesario: specifically, Cheung does not measure the attractiveness of "general" destination areas but develops a site-specific measure.

INTRODUCTION

The relationship between the use and the attractiveness of parks has intrigued many outdoor recreation researchers and, consequently, a number of sophisticated studies on park attractiveness have been generated. It is generally agreed among outdoor recreation researchers and planners that park-use levels are affected to a large extent by the attractiveness of parks. This general agreement evolved as the result of the simple observation that one park receives relatively more visitors than another (over the same time period) from a population centre, indicating that the difference in distance of the two parks from the population

centre is clearly not the only factor leading to the different levels of visitation.

If attractiveness is a valid concept, knowledge of attractiveness factors will enable a planner to make rational decisions about providing, preserving or developing these factors to make parks attractive, at least to a certain group (market). Thus there are both practical and academic motives for conducting attractiveness studies.

It would be tedious to continually reiterate that Cheung, Ross, and Cesario, whose measure of park attractiveness are considered, recognized the issue of attractiveness to whom, for what. But if one is to avoid needless qualms about the ideas presented here, it must be recognized that the Cheung, Ross and Cesario attractiveness measures discussed are for a fairly well defined type of park user. in other words, in what follows there is no endorsement of the fact that attractiveness of a site has meaning except in the context of a "reference group" of users, main destination day-users. Admittedly this "group" is not homogeneous. A more elaborated analysis should define week day and weekend attractivities separately and consider attractiveness in relation to main trip purpose (e.g picknicking, fishing, etc.). However, even the reference to main destination day-users is not continually repeated because reading and re-reading it becomes tedious.

REVIEW OF LITERATURE ON PARK ATTRACTIVENESS STUDIES

More than a decade ago, Clawson and Knetsch (See Reference 6) suggested the possibility of developing specific and "rather objective" rating scales to measure the attractiveness of outdoor recreation areas. Subsequently, various schemes to assess attractiveness were devised and reported. One type of attractiveness measure involved a particular characteristic of the site under consideration. For instance, Grubb and Goodwin (see Reference 14) and the Corps of Engineers (see Reference 8) used the surface area of a reservoir as a variable reflecting its attractiveness. (See also Reference 23.) Extending the concept of using a physical characteristic of a site as a variable reflecting site attraction, Cesario and others (see Reference 3) used several site characteristics to construct an attraction index for parks.

Taking a different approach, Van Doren (see Reference 12) conducted an "evaluation" of site attractiveness. In a camper study, he devised a camping attractiveness index for each of fifty Michigan state parks based on fifty-five variables related to (a) outdoor recreation activities, (b) natural environmental resources, and (c) camping facilities and services. Ellis used and developed Van Doren's approach to obtain measures of attractiveness that he employed in systems models. He also developed a measure of his own (see Reference 9, 10.) Recently, Ellis and Ker (Reference 11) used the Van Doren approach to study the attractiveness of

skiing areas, while Auger (Reference 1) used it to study the attractiveness of Quebec parks.

Both of the approaches described to this point have something in common, in that they relate park attractiveness to the characteristics of a park rather than deducing a park's attractiveness from the behavior of its uses. Cheung followed the lead of Clawson and the others cited and suggested that the attractiveness of a park for main-destination day-use is a function of the following form (for details, see TN 1):

(1) $$T(j) = @E\ S(e)\ @E\ R(m)\ Q(m)$$

WHERE:

$T(j)$ = attractiveness of park j,

$S(e)$ = relative popularity rating of activity e,

$R(m)$ = relative importance rating of facility m,

$Q(m)$ = rank or score of facility m, according to its quantity or quality.

In defining the measure it is accepted "that although not everybody will judge a facility in the same way, or perceive the same site factors as being the determinants of site attraction for day-visitors, there is a general concensus which can be reached" (quoted from unpublished material by Cheung). Indeed, Clawson and Knetsch (see Reference 7) have remarked, "Individual tastes vary greatly, yet there is some concensus as to what is good and what is fair, and there would often be general agreement as to what is poor".

In contrast to procedures that define park attractiveness based on park characteristics, Ross (see TN 2) suggested that the attractiveness of a site may be defined by studying consumer preferences, if certain conditions are satisfied. Basically, Ross considered that people show a preference when they travel to a site that is further than some alternative that would "serve their purpose". Employing logic to make deductions from his assumptions, Ross devised a three-step scheme to derive attractiveness measures for the same Saskatchewan parks for which Cheung had derived attractiveness figures.

The Ross and Cheung attractiveness measures are two of the three measures compared here. The third measure discussed is based on park users' behavior. Cesario (see Reference 4, 5 and TN 4) hypothesized that the number of visits, $V(i,j)$, made from an origin (i) to a destination (j), is a function of a number of explanatory variables related to (1) some characterisitcs of the origin (i), (2) some characteristics of the destination j, and (3) some costs due to the spatial separation of (i) and (j). He proposed:

(2) $V(i,j) = kE(i)A(j)f(C(i,j))e(i,j)$

WHFRE:

$V(i,j)$ = number of visits made from origin (i)to destination, (j) during a time period,

k = a proportionality constant,

$E(i)$ = emissiveness, or origin effect, of (i),

$A(j)$ = attractiveness, or destination effect, of (j),

$f(C(i,j))$ = a function of the cost, $C(i,j)$, for getting to destination (j) from origin (i)

$e(i,j)$ = an error term.

The fact that Cesario discussed how to derive the relationship between his attractiveness measure and park characteristics should not be taken to indicate that this measure is like the Cheung measure. Cheung defines the relation between attractiveness and park characteristics, while Cesario suggests that after peoples' response to a park has been estimated by obtaining an attractiveness value for a particular type of use, similar attractiveness values can be analyzed to see how peoples' responses are related to park characteristics. (TN 29 suggests a related strategy for assessing people's response to the supply of facilities available to them.)

THE ATTRACTIVITY MEASURES ANALYZED

As noted earlier, Cheung and Ross obtained main-destination day-use visitation attractivity indices for the same twelve Saskatchewan parks. Because their day-use attractiveness measures were available, Cesario calculated his measures for the same parks, with the assumption that the emissiveness of origins was proportional to the number of people resident in the origin areas. (On why this could or should be done see TN 4.) Thus, the attractivity measures presented in Table 1 were available for analysis.

Comparison of the attractivity measures should not be made using the Pearsonian correlation coefficient because Ross' measure is ordinal, so analysis was begun by computing the rank correlation coeficients shown in Table 2.

TABLE 1

THE ROSS, CESARIO, AND CHEUNG ATTRACTIVENESS INDICES FOR TWELVE SASKATCHEWAN PARKS

Park	T(r)	Rank	T(f)	Rand	T(c)	Rank
Buffalo Pound	.190	12	0.155	12	96.12	5
Cypress Hill	.732	2	3.083	2	45.26	11
Duck Mountain	.730	3	2.609	4	126.40	1
Echo Valley	.277	10	0.477	10	112.05	3
Good Spirit	.390	9	0.666	9	76.56	8
Green Water	.456	7	0.898	6	61.46	9
Prince Albert	.821	1	1.416	5	88.75	7
Moose Mountain	.473	6	3.846	1	113.11	2
Pike Lake	.614	5	0.704	7	96.10	6
Rowan's Ravine	.266	11	0.683	8	59.01	10
Battleford's	.619	4	2.886	3	104.28	4
Besant	.439	8	0.373	11	26.60	12

T(r) - Ross' attractiveness indices

T(f) - Cesario's attractiveness indices

T(c) - Cheung's attractiveness indices

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DISCUSSION

When Table 1 is examined, it becomes clear that a major reason for the high rank correlation of .77 between Cesario's attractiveness measures and those of Ross is that six parks have almost the same ranks on the two measures. Actually, the ranks of six parks agree fairly well when the Cheung and Cesario attractivity measures are compared, but in this case an overall rank correlation of only .25 is observed.

However, having seen how well the Cesario and Ross attractivity measures agree, one should note that the Cheung measure possibly should not exactly agree with the Cesario attractivity measure. Cesario claims that his emissiveness measure includes an alternative factor component and because of the symmetry of his equation it is plausible to suggest that attractivity is also affected by a destination alternative factor. Cheung's measure, on the other hand, deals only with a given site. It is possible that Cesario's measure reflects both positive and negative effects of the area around a park. (This point is elaborated in TN 33.) This suggests that the Cesario attractivity measure, T(f),

TABLE 2

RANK CORRELATION COEFFICIENTS BETWEEN THE ROSS, CESARIO, AND CHEUNG ATTRACTIVENESS INDICES FOR 12 SASKATCHEWAN PARKS

	T(r)	T(f)	T(c)
T(r)	*	.77	.21
T(f)		*	.10
T(c)			*

T(r) – Ross attractiveness indices
T(f) – Cesario attractiveness indices
T(c) – Cheung attractiveness indices

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could be a function of Cheung's attractivity measure, T(c), and Cheung's (1972) alternative factor A(c):

(3) $$T(f) = f(T(c), A(c))$$

which might be:

(4) $$T(c)/T(f) = C0 - C1\ A(c)$$

The possible existence of such a relation is demonstrated by the results presented in Table 3. In particular, it is interesting to note that by using Equation 5,

(5) $$\hat{T}(f) = T(c)/27A(c) - 125$$

based on parameters for Regression (1) of Table 3, one predicts the twelve "corrected" values of Cheung's attractivity measures given in Table 4. But when rank correlations are carried out using the "corrected" Cheung measure, one notes that the correlations reported in Table 4 are observed. The correction has not improved the rank correlation between the Cheung and Cesario attractivity measures as might have been expected.

Even though the results raise questions without providing impressive evidence for a given answer, the relation defined by Regression (1) and, in fact, the relation implied by any significant regression coefficient

TABLE 3

RATIO OF CHEUNG'S ATTRACTIVENESS MEASURE, T(c), TO CESARIO'S ATTRACTIVENESS MEASURE, T(f), EXPLAINED BY A DESTINATION ALTERNATIVE FACTOR, A: T(c)/T(f) = C0 + C1A

Regre Num	C0	C1	A = Alternative Factor defined by	F-test Significance Level	R^2
1	-126	27	No. of alternative sites within 100 miles of the park under consideration	10%	0.30
2	-49	144	1/D **1/2 as used by Cheung 1972	Not Significant	0.18

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of the alternative factor means that when a site is "imbedded" in a collection of other sites, its "true" or "absolute" (Cheung type) attractivity is not estimated by the Cesario attractiveness measure. In fact, a significant coefficient suggests that persons may be making decisions based first on selecting a region and then selecting a site within a region (rather than considering all sites as discrete). It is possible to believe that persons may view a number of parks in an area as equally attractive (in Cheung's sense). They may view similar parks in the same area much as they view a single park with a number of different day-use areas. In this case, visitor flows to an area, not to each site, would be what reflect regional attractivity. In fact, a sophisticated analysis of total flow might give an overall attractivity number that could be "decomposed" using flows to each one of several sites in an area to get absolute Cheung-type site-specific attractivity measures. (See TN 33.)

CONCLUSION

The preceding may have glossed over what may prove to be the most important point made in this article - that Cheung (see TN 1), following the lead of others, found it appropriate to suggest that the use of a site will be influenced by the number of sites around it and their

TABLE 4

RANKINGS OF ATTRACTIVENESS
OF TWELVE SASKATCHEWAN PARKS
BASED CESARIO'S MEASURE*
AND AN ESTIMATE OF IT
BASED ON THE RELATIONSHIP:

$$\hat{T}(f) = T(c)/(-126 + 27A(c))$$

Park	Rank of T(f)	T(f)	Rank of $\hat{T}$(f)	$\hat{T}$(f)
1	12	0.155	9	0.345
2	2	3.083	12	-2.514
3	4	2.609	2	2.006
4	10	0.477	5	0.778
5	9	0.666	8	0.532
6	6	0.898	4	0.976
7	5	1.416	1	9.861
8	1	3.846	6	0.661
9	7	0.704	3	1.525
10	8	0.683	10	0.234
11	3	2.886	7	0.610
12	11	0.373	11	0.156

P = a particular park
$\hat{T}$(f) = estimated Cesario attractiveness factor for P
T(c) = actual Cheung attractiveness factor for P
A(c) = number of parks that are within 100 miles of P
* Pank Correlation of T(f) and $\hat{T}$(f) = .23

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relative attractivity. Work carried out after the first version of this paper was written (see TN 33) has shown that if the kind of effect that Cheung thought existed did in fact, exist, Cesario would estimate it as part of his attractiveness measure. Cheung's attractiveness measure obviously does not depend on what is around a park. So, the relationship between the Cheung and Cesario measure established here was to be expected on theoretical grounds.

In light of these findings, two tentative conclusions are clear; (1) Ross' and Cesario's indices of attractiveness can reasonably be considered to measure much the same thing (though Ross in ordinal and Cesario in interval scale terms) and (2) Cheung measures something different from Ross and Cesario in that he does not measure the attractiveness of "general" destination areas, but

develops a site specific measure.

An overshadowing concern in this paper has been that one must determine the attractiveness of a park in terms of the types of activities it offers to the visitors who are there for a given reason. Attractivities of "activity packages" for different types of users must ultimately be a focus of attention. A park may be very attractive to a certain group of people having a certain time budget, (and depending on their interests) while it may be not at all attractive to another group of people, either because of the facilities offered or time constraints. In this analysis the visitors' perceptions of attractiveness have been aggregated to some degree in considering main-destination day-users as a homogeneous group of users by considering that they use parks for a single reason and that all such users have the same "utility" scale.

If a great value of site attractiveness studies lies in providing insights into the social psychology of participation in outdoor recreation much interesting work remains to be done on measuring attractivity, particularly as it relates to attractivity to whom, for what. It seems clear that Ross and Cesario have given important, new and highly related measures that can be used in pursuing research and planning ends related to measuring the attractiveness of recreation sites or areas.

A COMPARISON OF THE REGRESSION RESULTS OF APPLYING TWO ATTRACTIVENESS FACTORS TO ESTIMATE PARK USE

H.K. Cheung

ABSTRACT

In this paper, the results of using two attractiveness factors in regressions designed to estimate park use are compared. The two attractiveness factors thus compared were derived by two independent approaches. Cheung's measure was derived by applying a formula that relates attractiveness to characteristics of a park and popularity of activities that can be participated in within the park. Cesario's measure, in contrast, is defined by visitor flows from various origins to parks.

The explanatory power associated with each attractiveness was found to depend on the particular form of the estimating equation used. This finding led to the conclusion that neither the Cheung, nor the Cesario, attractiveness factor performs better than the other.

INTRODUCTION

Cheung, in an attempt to explain the variance found in a set of Saskatchewan main destination day-user data (see TN 1) developed the following model using multiple regression analysis:

$$(1)\quad V(i,j) = 1.33 + (120.31P(i) - 36.60P(i)A(i) + 1.25T(j) - 104.56)/g(D(i,j))$$

WHERE

V(i,j) = the number of vehicles in hundreds travelling to park j from origin i per season,

P(i) = population, in thousands, of origin i,

D(i,j) = road distance in miles, from origin i, to park j,

A(i) = alternative factor for origin i,

Σ 1/D(i,k)**(1/2), D(i,k) $\leq$ 100 miles (sum on k)

0 otherwise

i = 1, ..., 231

$j \neq k = 1, \ldots, M$ and j refers to the park under consideration,

$T(j)$ = attractiveness of park j, and

$$g(D(i,j)) = D(i,j)^{1/2} \qquad 0 < D(i,j) < 20,$$

$$g(D(i,j)) = D(i,j) \qquad 20 \leq D(i,j) < 55,$$

$$g(D(i,j)) = D(i,j)^{3/2} \qquad 55 \leq D(i,j)$$

How Cheung defined and measured $T(j)$, the attractiveness of park j, is not of immediate concern here but it should be noted that $T(j)$ explained less than one per cent of the total variance in $V(i,j)$, the dependent variable. Doubts were thus raised about the soundness of the way $T(j)$ was derived. The question was asked: Given the same set of Saskatchewan data and the same functional form, could an independent approach of measuring park attractiveness explain more variance than did Cheung's?

The purpose of this paper is to answer that question and comparison is made of the results obtained by using two attractiveness factors derived from the two approaches designed to measure park attractiveness, one by Cheung (1972), the other by Cesario (1973).

THE CHEUNG AND THE CESARIO ATTRACTIVENESS MEASURES

Traditionally, there have been two approaches to defining park attractiveness. The first is of an inductive nature and has so far been used more frequently than the second, which is a deductive approach. In the inductive approach specific components (elements) of attractiveness are designated, often subjectively. They may consist of the number of picnic tables, the length of a swimming beach, water quality and so on, depending on the type of users under study. Each component is given a score, based on some quantity or quality criteria and a numerical value. The "attractiveness of a park" is calculated by algebriacally combining the scores. The Cheung attractiveness measure, used in the Saskatchewan study referred to in the introduction, is an example of an inductively defined measure.

Briefly, Cheung took the attractiveness of a park with regard to a particular use (e.g., main destination day-use) to be measured by a weighted sum of scores for the day-use facilities offered at that park. Weights were defined on the basis of popularity of activities among the other considerations, but information on the day use of the park was not used in defining its attractivity.

The deductive approach to defining a measure of park attractiveness involves computing a numerical value reflecting attractiveness of a park based on analysis of

visitor flows (in this case day-use flows) that the park receives. Cesario has defined a way of estimating attractiveness measures using a deductive approach (see TN 4). So has Ross (see TN 2) although his measures are ordinal.

COMPARISON OF MEASURES

The attractiveness measures as developed by Cheung and Cesario represent two theoretical constructs designed to determine the relative attractiveness of parks. Although the measures were developed using different approaches, they both were intended to produce a "formula" for calculating park attractiveness which a park planner or model builder could use to advantage.

It was recognized that with the Cesario attractiveness measure available for Saskatchewan, it would be possible to use the data to compare the measures's "performance" with that of Cheung. So Cesario's method was used to derive attractiveness estimates for the twelve Saskatchewan parks for which Cheung had made estimates (see TN1). To do so, it was necessary to apply Cesario's model (Equation 4 in its logarithmic form) to the Saskatchewan main destination day-use data used previously by Cheung. The Cheung and the Cesario attractiveness values of the parks under study are presented in Table 1.

It should be noted that the absolute values of the Cheung or Cesario park attractiveness factors are not important. Rather, it is the relative values that are meaningful. For example, the relative attractiveness of Good Spirit provincial park to that of Moose Mountain provincial park is 0.68 (= 76.56/113.11) according to the Cheung attractiveness scale and 0.62 (= .93/1.50) according to the Cesario attractiveness scale. (The Cheung and the Cesario attractiveness scales both have the properties of direction and magnitude and are said to be interval scales.)

After the two sets of attractiveness values were obtained, they were used in separate regression runs to explain the number of visits from different origin areas to the twelve Saskatchewan parks considered in this analysis. Actually, three sets of regression runs using the attractiveness values and other regressors were made. There are, of course, an infinite number of regressions that could be made containing the attractiveness factor. The three following functional forms (Equations 2, 3, and 4) chosen in this study are some of the commonly used functional forms.

(2) $E(V(i,j)) = C0+(C1P(i)+C2P(i)A(i)+C3T(k)+C4)/g(D(i,j))$

(3) $E(V(i,j)/P(i)) = C5 + (C6A(i) + C7T(k))/g(D(i,j))$

(4) $E(\log((V(i,j) + 1)/P(i,j))) = C8 + C9 \log A(i) + C10 \log(Di,j) + C11 \log T(k)$

TABLE 1

THE CHEUNG AND THE CESARIO ATTRACTIVENESS FACTORS OF TWELVE SASKATCHEWAN PARKS*

Park	Cheung	Cesario
Buffalo Pound	96.12	0.55
Cypress Hill	45.26	2.02
Duck Mountain	126.40	1.52
Echo Valley	122.05	.63
Good Spirit	76.56	.93
Green Water	61.46	1.06
Prince Albert	88.75	1.46
Moose Mountain	113.11	1.50
Pike Lake	96.10	0.83
Rowan's Ravine	59.01	0.65
Battleford's	104.28	1.59
Besant	26.60	0.51

* The Pearson product moment correlation ceofficient between the two sets of factors is 0.28.

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WHERE

$T(k) = T(j)$ or $T(f)$

$T(j)$ = the Cheung attractiveness factor,

$T(f)$ = the Cesario attractiveness factor,

$C0, \ldots, C11$ = parameters to be estimated, and

$E(\ )$ = the expected value of the quantity in ( )'s.

The equations derived were:

$$(5)\quad V(i,j) = 1.33 + (120.31P(i) = 36.60P(i)A(i)+1.25T(j) - 104.56)/g(D(i,j))\ \text{(Cheung)}$$

$$(5a)\quad V(i,j) = 1.32 + (116.54P(i) - 34.60P(i)A(i) + 106.19T(f) - 118.08)/g(D(i,j))\ \text{(Cesario)}$$

$$(6)\quad V(i,j)/P(i) = 0.07+(0.97T(j)-7.56A(i))/g(D(i,j))\ \text{(Cheung)}$$

$$(6a)\quad V(i,j)/P(i) = 0.11 + (70.38T(f) - 6.33A(i))/g(D(i,j))\ \text{(Cesario)}$$

$$(7)\ \log((V(i,j) + 1)/P(i)) = 2.65 + 0.19 \log T(j) - 1.83 \log D(i,j) - 0.581 \log A(i) \quad \text{(Cheung)}$$

$$(7a)\ \log((V(i,j) + 1)/P(i)) = 3.10 + 1.21 \log T(f) - 1.88 \log D(i,j) - 0.33 \log A(i) \quad \text{(Cesario)}$$

TABLE 2

STATISTICS ON THE REGRESSION COEFFICIENTS OF EQUATION 5*

Regression Coefficient	Value	Standard Error	F-Value	R^2
constant	1.33			
P(i)/g(D(i,j))	120.31	5.80	429.80	0.8416
P(i)A(i)/g(D(i,j))	- 36.60	3.12	137.81	0.9029
1/g(D(i,j))	-104.56	27.30	14.63	0.9088
T(j)/g(D(i,j))	1.25	0.40	9.85	0.9048

* The F-value and the standard error of estimate of this equation are 562.93 and 7.59 respectively, with 226 error degrees of freedom. Also all regression coefficients are significant at the one per cent probability level and all have the expected signs.

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In the first set of regressions (see Tables 2 and 3) both the Cheung and Cesario attractiveness factors, when combined with the explanatory variable defined by the distance function g(D(i,j)), did almost equally poorly in explaining the variance found in the Saskatchewan day-use data. The reason may be that the regressors P(i)/g((D(i,j)) and P(i)A(i)/g(D(i,j)) explained so much variance (about 90 percent) in the day-use data that there was not much variance left for the attractiveness regressor to explain.

In the second set of regressions (see Tables 4 and 5) the Cheung attractiveness factor, when combined with the distance function g(D(i,j)), explained 69 percent of the total variance in the data. On the other hand, the Cesario attractiveness factor, when combined with the same distance function, explained 66 percent of the total variance. The reason why the attractiveness regressors had so much explanatory power when the dependent variable was defined as participation rate is not clear. The author's conjecture is that it may have something to do with the constant variance assumption implicit in ordinary least squares (OLS)

regression that was used in this study. Certainly, in the Saskatchewan main destination day-use data, large flows were associated with large population centers. Thus, when the flows were "weighted" by the corresponding populations, the homogeneous variance assumption of OLS was more nearly met than when they were not weighted. (On this problem, see TN 19).

TABLE 3

STATISTICS ON THE REGRESSION COEFFICIENTS OF
EQUATION 5a*

Regression	Standard			
Coefficient	Value	Error	F-Value	R^2
constant	1.32			
P(i)/g(D(i,j))	116.54	5.61	430.99	.8416
P(i)A(i)/g(D(i,j))	- 34.06	3.02	127.62	.9031
1/g(D(i,j))	-118.08	31.42	14.13	.9049
T(f)/g(D(i,j))	106.19	34.13	9.68	.9089

* The F-value and the standard error of estimate of this equation are 563.37 and 7.59 respectively, with 226 error degrees of freedom. Also all regression coefficients are significant at the one per cent probability level and all have the expected signs.

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It is seen from Tables 4 and 5 that the Cheung attractiveness regressor, T(j)/g(D(i,j)), had a better overall performance than the Cesario attractiveness regressor, T(f)/g(D(i,j)), in terms of a larger ratio of the regression coefficient to its standard error (.97/.06 = 16.17 versus 70.38/4.42 = 15.92), and a higher increase in the R^2 (.6862 versus .66.2). It is also seen that Equation 6 incorporating the Cheung attractiveness regressor has a smaller standard error of estimate than the Equation 6a incorporating the Cesario attractiveness regressor.

In the third set of regressions the functional form of the estimating equation was double-logarithmic. This time, as seen from Tables 6 and 7, there was a decrease in explanatory power of the regressor containing the Cheung attractiveness factor and the Cheung attractiveness regressor was not found to be significant. There was, however, a marked improvement in the explanatory power of the regressor incorporating the Cesario attractiveness factor. This was to be expected, since the Cesario

TABLE 4

STATISTICS ON THE REGRESSION COEFFICIENTS OF EQUATION 6*

Regression	Standard			
Coefficient	Value	Error	F-Value	R^2
constant	0.07			
T(j)/g(D(i,j))	0.97	0.06	297.22	.6862
A(i)/g(D(i,j))	-7.56	2.98	6.41	.6947

* The F-value and the standard error of estimate for this equation are 259.46 and 1.32 respectively, with 228 error degrees of freedom. Also all regression coefficients are significant at the one per cent probability level and all have the expected signs.

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attractiveness factor was derived using an Equation that is very similar to Equation 7a, the estimating equation.

SUMMARY AND CONCLUSIONS

In this paper two methodologies designed to measure the attractiveness of a park have been evaluated. The Cheung attractiveness measure was based on an ad hoc definition procedure developed by an inductive approach so that an overall rating of a site could be arrived at by considering a set of site characteristics and services offered. The Cesario attractiveness measure was a component of a trip-making model, the number of trips made from an origin to a destination considering spatial operation. It is estimated, based on a function of the Characteristics of the origin, the characteristics of the destination, and the spatial separation of the origin and the destination. Cesario's measure of attractivity was thus described as being defined deductively.

Using Equation 2, 3, and 4 to compare the effectiveness of the two attractiveness factors, using the regression results, and based on using the increase in the R^2 value as the main criterion for judging the performance of the Cheung and Cesario attractiveness factors, it is difficult to say whether one performs better than the other. The regression results presented showed that the efficiency of the attractiveness factors depended on the particular form of the estimating equation used. One can see the problem by noting that when the dependent variable was defined as

TABLE 5

STATISTICS ON THE REGRESSION COEFFICIENTS
OF EQUATION 6a*

Regression	Standard			
Coefficient	Value	Error	F-Value	R^2
constant	0.11			
T(f)/g(D(i,j))	70.38	4.42	253.71	.6610
A(i)/g(D(i,j))	-6.33	3.12	4.11	.6670

* The F-value and the standard error of estimate of this equation are 228.53 and 1.38 respectively, with 228 error degrees of freedom. Also all regression coefficients are significant at the one per cent probability level and all have the expected signs.

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participation rate, the Cheung attractiveness regressor, defined as T(c)/g(D(i,j)), slightly outperformed the Cesario attractiveness regressor, defined as T(f)/g(D(i,j)). However, when the dependent variable used was log((V(i,j) + 1)/P(i)), the Cesario attractiveness regressor, defined as log T(f), greatly outperformed the Cheung attractiveness regressor, defined as log T(c), in the sense that the former explained more than ten percent of the total variance whereas the latter explained less than one percent.

TABLE 6

STATISTICS ON THE REGRESSION COEFFICIENTS OF EQUATION 7*

Regression	Standard			
Coefficient	Value	Error	F-Value	R^2
constant	2.65			
log D(i, j)	-1.82	0.09	411.78	0.6385
log A(i)	-0.58	0.11	27.30	0.6791
log T(j)	0.19	0.14	1.84	0.68.7

* The F-value and the standard error of estimate of this equation are 162.06 and 0.39 respectively, with 227 error degrees of freedom. Also all regression coefficients are significant at the one per cent probability level except that of log T(j) which is not significant, and all have the expected signs.

TABLE 7

STATISTICS ON THE REGRESSION COEFFICIENTS OF EQUATION 7a*

Regression	Standard			
Coefficient	Value	Error	F-Value	R^2
constant	3.10			
log D(i, j)	-1.88	0.08	562.18	.6385
log A(i)	-0.33	0.10	10.05	.7389
log T(f)	1.02	0.13	64.30	.7500

* The F-value and the standard error of estimate of this equation are 226.95 and 0.34 respectively, with 227 error degrees of freedom. Also all regression coefficients are significant at the one per cent probability level and all have the expected signs.

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CORD STUDY TECHNICAL NOTE 27

PERCEPTION OF QUALITY OF WILD RIVERS

P. Juurand, V. Guzelimian, and J. Beaman

ABSTRACT

A group that was in the organization that was the Planning Division of Parks Canada in 1972 carried out Wild Rivers Surveys to develop a technique for designating rivers with National wild river potential. The surveys had the objective of developing an input to the systematic selection of National Wild Rivers. However, this project also resulted in the possibility of learning something about how expert canoers' ratings of sites on wild rivers relate to the "resources" at those sites.

Understanding how "resource" variables are related to the perceived quality of a given segment of a river, a site, was pursued by determining how well an average site score for the 4 persons who rated each site was explained by each of three models. The simplest model considered a multivariate regression model in which only interval variables were used. The second model was the more general ANOVA, analysis of variance model, which allowed for nominal variables and non-linear relations between each resource variable and the dependent variable, site quality. Finally, the most general model used was the Michigan AID, Automatic Interaction Detection model (the computer program produces a "model"). The three analysis explained 38%, 64%, and 84% of the variance in average site quality scores respectively.

Statistical tests are presented to show that the improved results based on the different analyses of 212 Wild River sites on which data were collected in 1972 did not occur by chance. The conclusion is that the improvement from model to model is unquestionably real!

Two types of implications of the analysis are pointed out. The first type of conclusions are methodological. The other has to do with the planning use of models. The conclusions suggest very limited value in using "perceived" site quality models for planning because of problems of site use for what, by whom, under what conditions, etc. The paper makes it clear that the comments do not refer to the merits of developing and using "engineering" and "biological" land capability models but to using models of human perception.

PURPOSE

This paper attempts to answer basic questions relating to the use of models in order to show how resource variables are related to the qualities assigned by a jury of expert canoeists to specific sites on a number of Canada's Wild Rivers.

From a social-psychological perspective the concern is with, for a given type of site and user: (1) what variables influence the decision that a site has a given quality, and (2) how a person's decision on the quality of a site is influenced by the ranked importance of physical, historical and biological variables and in what manner do the combination of the judgments on each variable produce an overall judgment of a site's quality.

From a mathematical point of view the question is whether a simple linear model or a more elaborate model is required to explain the Wild River Site quality ratings.

From a parks planning viewpoint, the concern is: (1) to demonstrate how to determine which resource variables are important in the site quality rating, (2) to comment on whether or not resource information (natural, historical and biological) can be used in defining the quality of an area that will be perceived by a given type of user, and (3) to shed some light on whether or not site quality estimates can be obtained with enough social-psychological and statistical confidence that they can reasonably be used in planning.

THE PROBLEM

Any discussion of the attractiveness of landscapes raises the problem of how a person reacts to resource variables when judging the quality of a site. To pursue but one example, the Shafer et al (1969) study (see Reference 19) indicates that people do not react to resource variables in a linear way. Shafer's models, by their structure, imply that they react independently to different resource variables and that their responses to different variables combine additively.

Do people in the real world react to situations by mentally adding up the effect of each resource variable to get a "composite" quality rating? Obviously, they do not do it consciously, so it is necessary to consider the possibility that when an individual reacts to a site, that reaction is (firstly) not necessarily linear or curvilinear and (secondly) not necessarily defined by independent reactions to each of several resource variables.

From a mathematical perspective, the preceding ideas can be dealt with by accepting that the perceived "quality" of a site on a wild river (in relation to the use of the river for a given purpose) is determined by an individual in a rational, predictable and statistically reproducible way. Accepting this statement acknowledges that the following type of equation may be used to define the quality of a

site:

$$a(s) = F(X(1), X(2), X(3), \ldots, X(n)) + E(p)$$

WHERE

$a(s)$ = Quality of a particular site, s, as perceived by a given type of person, for a given purpose;

$F(\ )$ = some function;

$X(i)$ = the score of site s on resource variable i; and

$E(p)$ = a unique "error" related to variability in perception, with (p) being a subscript that refers to a particular rating by a given person on a given occasion.

Whether or not the rating of a site is made in a linear way is then a matter of determining whether F( ) is a linear function of X(1), X(2), etc. And if decisions are made in other ways, by determining if F( ) is a different kind of function of the resource variables, is another matter that must be resolved.

THE DATA

As shown in Figure 1, the rivers for which data were collected in the 1972 Parks Canada Wild Rivers Survey were those flowing through the Mackenzie Mountain section of the Western Cordillera, the Barrenlands and Tundra Hills of the Canadian Shield, the Boreal Uplands of Saskatchewan, the Laurentian and east coast regions, and the rivers in the Appalachian mountain system of Newfoundland. They were studied by crews of two 2-man canoe teams. Four crews were in the field in 1972.

The data were collected from sites on the rivers where major or minor changes in the river and the river valley environs were observed to take place. Major changes were considered to be those where a lasting change took place (e.g. from a V-shaped straight valley to a broad flood plain with a meandering channel); minor changes were defined as spot locations of scenic, historic or cultural interest. (See the list of References for survey reports.)

A survey site was a 200-to 500-yard reach, or two to three stream-widths of a river that best illustrated one of the following:

Upstream starting point
Change in water pattern: rapids to slow moving water
Change in water pattern: slow moving water to rapids
Change in valley: from flats to canyons
Change in valley: from canyons to flats
Change in river or valley caused by intersection
  with major river

Figure I

RIVERS STUDIED IN THE 1972 WILD RIVERS SURVEY

Mouth of river
Points of historic interest
Major resource developments or townsites
Spectacular or scenic sites that do not fall into the above categories (e.g. waterfalls, a particularly attractive bend in a canyon, etc.)

When collecting data, crews were instructed not only to note the reason for choosing an area as a sample site but also to record the type of sample. Secondary and tertiary reasons for choosing a site were also to be recorded. Crews were also required to record the number of miles between sites as an indication of the frequency of changes along the course of the river.

The variables chosen to describe site characteristics are shown in Figure 2. The codes for some of them are given in the Appendix but other variable values are not shown there because they can be read from the Inventory Coding Form also given in Figure 2. Of all the variables listed on the Inventory Coding Form, only stream order and sinuosity were found to be interpreted inconsistently. They were not coded and therefore do not appear in the Appendix.

One change between the 1971 Wild River Survey and the 1972 survey was the recording of site ratings. Each crew member rated each site subjectively on a 10-point scale. The average measure for a site is the dependent variable describing site quality used in the analysis. Although individual crew members had varying backgrounds and tastes, all were expert canoeists with extensive experience in wilderness and river environments. Thus their ratings, while varying according to personal preference, can be expected to reflect a homogeneity of judgment due to similar to, and interest in, extensive wilderness travel.

ANALYSIS

In the following, three terms are used to describe data analysis approaches. 'Simple regression' refers to a "standard" regression analysis in which both the independent and dependent variables are continuous (interval) and the dependent variable is explained by a mean plus a sum of regression coefficients times their respective variables. 'ANOVA' (analysis of variance) is used in a fairly well accepted way to refer to an analysis where the independent variables are nominal, having values such as married, single, divorced, rather than being intervals. (See Reference 20.) In this analysis, "effects" for each value of each variable are calculated (see Figure 2). A very simple illustration of the kind of results obtained, using this analysis method, is available in the CORD Study TNs No. 12 and 15. Finally, 'AID' (see Reference 21) is based on a computer program that performs a search for a structure in data in a more general way, using less restrictive assumptions, than does ANOVA. (For an example of the use of

WILD RIVERS SURVEY 1972
FIELD INVENTORY CARD

River Name ____________________

Site Name ____________________

Date: Day | Mon.

Natural Region

Sample Type 1 2 3

Miles to next site

PHYSICAL FACTORS

Stream Order

River Width Low Flow
(feet) Bank Full

Mean Depth (feet)

Velocity (ft./sec.)

Gradient (ft./mile)

Drainage Area (sq. miles)

Water Temperature (°F)

Sin· osity

Width of Valley Flat (feet)

Flow Variability

Channel Pattern	1. Lake & Stream	2. Braided	3. Braids & Meanders	4. Meander	5. Straight Channel
Stream Bed material	1. Clay or Silt	2. Organic Sediment	3. Gravel	4. Cobbles	5. Rock or Boulders
Water Pattern	1. Smooth	2. Surges	3. Riffles	4. Chutes & Rapids	5. Torrent or Waterfall
Flow Level	1. High	2. Medium	3. Low		
Predominant Fluvial Process	1. Erosion	2. Erosion & Deposition	3. Deposition		

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SCENIC & HUMAN INTEREST FACTORS

Litter	1. Absent	2. Infrequent	3. Present but Unobtrusive	4. Frequent	5. Extremely Littered	☐
Artificial Controls	1. Free & Natural	2.	3. Present but Unobtrusive	4.	5. Dam	☐
Accessibility	1. Trail, canoe or plane	2.	3. Logging road or shallow draught power	4.	5. Highway or Steamer	☐
Land Use	1. Wilderness	2. Pioneer Area	3. Agriculture	4. Extractive Resource	5. Urban	☐
Utilities	1. None	2.	3.	4.	5. Scene obst. by utilities	☐
Historic Sites Buildings or Features	1. None	2.	3.	4.	5. Many	☐
Significance	1. N.A.	2. Local	3. Regional	4. National		☐
Condition	1. N.A.	2. Bad	3. Fair	4. Excellent		☐

Present Recreational Use (users/season) ☐☐☐☐ Height of Highest Visible Point (feet) ☐☐☐☐

Vertical View Confinement (degrees) ☐☐ Horizontal View Confinement (degrees) ☐☐

Downstream Visibility (feet) ☐☐☐☐☐ Upstream Visibility (feet) ☐☐☐☐☐

Crew Ratings ☐☐ ☐☐ ☐☐ ☐☐

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BIOLOGIC & WATER QUALITY FACTORS

Pollution Evidence	1. None	2.	3.	4.	5. Very Evident	☐
Water Colour	1. Colourless	2. Blue	3. Green	4. Brown	5. White	☐
Turbidity	1. Clear	2. Cloudy	3. Turbid	4. Very Turbid	5. Muddy	☐
Floating Material	1. None	2. Vegetation	3. Foam	4. Oil	5. Variety	☐
Algae	1. Absent	2.	3.	4.	5. Infested	☐
Plants	1. Absent	2.	3.	4.	5. Infested	☐
Fauna Mammals	1. None	2.	3.	4.	5. Large Variety	☐
Waterfowl	1. None	2.	3.	4.	5. Large Variety	☐
Fish	1. None	2.	3.	4.	5. Large Variety	☐
Land Flora Association	1. Tundra	2. Spruce & Birch	3. Hemlock & Cedar	4. Grass Lands & Mixed Woods	5. Mixed Conifers & Hardwoods	☐
Density	1. Thin	2.	3.	4.	5. Dense	☐
Diversity	1. Small	2.	3.	4.	5. Great	☐

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AID, see TN 4.) The authors are not concerned with the fact that regression analysis can be employed to carry out an analysis of variance by what is often called the dummy variable approach. By 'simple regression' they mean that no nominal variables or interaction effects are built into a model. Similarly, by analysis of variance they mean straightforward analysis of variance.

Since use of linear regression analysis of variables with more than two values requires that variables be interval, only interval variables having a logical bearing on landscape preference were selected for analysis. The variables that could be used were correlated, and some of those exhibiting high correlations with other variables ($r \geq .8$) were eliminated by keeping only one variable of a set of highly intercorrelated variables.

After this screening a multiple regression analysis was carried out. Using the average crew ratings as the dependent variable and the "dimensions" of the environment listed below, it was possible to determine relationships between the quality measure and the selected environmental variables. The regression model derived is given by the following equation, for which standard errors in the regression coefficients are shown in parentheses:

(1)

$$\begin{aligned} Y = 2.686 &- \underset{(.17)}{0.19}\, X10 - \underset{(.08)}{0.18}\, X12 - \underset{(.15)}{0.05}\, X22 - \underset{(.08)}{0.08}\, X24 \\ &- \underset{(.11)}{0.03}\, X25 - \underset{(.14)}{0.51}\, X29 - \underset{(.20)}{0.52}\, X33 - \underset{(.01)}{0.02}\, X37 - \underset{(.07)}{0.17}\, X39 \\ &- \underset{(.16)}{0.32}\, X54 - \underset{(.10)}{0.05}\, X56 - \underset{(.14)}{0.35}\, X58 - \underset{(.11)}{0.46}\, X60 - \underset{(.14)}{0.25}\, X61 \end{aligned}$$

WHERE: X10 is the mean depth of the river;

X12 is the gradient of the river at the site;

X22 is the velocity of the river;

X24 is the coarseness of the stream bed material;

X25 is the degree of turbulence on water's surface;

X29 is the degree of artificial channel control (recognized as a questionable variable to be considered as interval);

X33 is the angle between horizontal and highest visible point;

X37 is the height above the river of the highest visible point;

X39 is the angle between horizontal and highest

visible point;

X54 is the amount algae (recognized as a questionable variable to be considered as interval);

X56 is the number of mammals;

X58 is the number of fish;

X60 is the density of land flora; and

X61 is the diversity of land flora.

The analysis of variance presented in Table 1 shows that the regression resulted in a significant relationship with a F = 10.22, which has a probability of less than .005 of occuring by chance. The R^2 value obtained was .38. The F-test clearly indicates that the null hypothesis of no relation must be rejected. But the R^2, while acceptable mathematically, hardly suggests that the model is usable for planning purposes. In descriptive terms, the low value of R^2 means that a prediction of site quality has a high probability of being very much in error (being high when it should be low and vice versa).

TABLE 1

ANALYSIS OF VARIANCE TABLE
FOR THE SIMPLE LINEAR REGRESSION

Source of Variation	Degrees of Freedom	Sum of Square	Mean Square
Regression	14	415.667	26.69
Residual	225	653.6	2.90

F-Ratio = 10.22*

* significant at .005 level.

<><><><><>

Turning to analysis of the data using analysis of variance, it should be noted that the following equation was assumed to be appropriate to explain site quality ratings:

(Quality of a River Site i) =

General mean + gradient effect at site i + valley width effect appropriate to site i + bank width effect + velocity effect + stream bed material effect + water pattern effect + fluvial process effect + artificial control effect + access effect + land use effect + utilities effect + historic sites effect + height of highest point effect + vertical view confinement effect + horizontal view confinement effect + downstream view effect + upstream view effect + pollution effect + water colour effect + turbidity effect + floating material effect + algae effect + plants effect + flora effect + flora density effect + flora diversity effect + mean depth effect.

Expressed differently, Equation 2 shows that the effect for each level of the variables that apply to a given site is added to give a predicted quality as follows:

$$(2)\quad Y(i) = U + B(1,i) + B(2,j) + B(3,k) + \ldots + B(L,m) + \ldots + B(n,61)$$

WHERE $Y(i)$ = the quality rating of site i

U = the general level of site quality

$B(1,i)$ = the effect of level i of variable 1

$B(2,j)$ = the effect of level j of variable 2

$B(3,k)$ = the effect of level k of variable 3

$B(L,m)$ = the effect of level m of variable L,

$B(n,61)$ = the effect of level n of variable 61.

A computer program was used to perform the generalized analysis of variance. The R^2 value for the analysis was .594. The b's for Equation 2 are listed in the Appendix, which gives the names of all variables and the values that they were allowed to take along with the constant U, the general mean. The coefficients listed in the table are often called the beta coefficients of a particular level or value of a variable: in statistics one often uses level whereas in the SPSS computer program one refers to variables and their value tables.

Figures 3 through 5 were prepared by plotting the beta values for each level value of the variables used to explain site quality. For example, looking at the turbidity variable, one sees that the bar showing its value is close to 0 for level 1, extends above 0 for level 2, and drops below 0 for level 3. These results show that for higher turbidity levels (2 rather than 1) the turbidity effect is

higher. However, when turbidity is 3, the turbidity effect is lower than for a turbidity of 2. The respective effects are .052, .320, and -.372 as indicated in the Appendix.

When the largest (positive) value for turbidity, .320, is added to the general mean for quality, 6.167, the perceived site quality score is 6.487. When the lowest beta value for turbidity -.372 is added, the score is 6.795. Thus, recognizing that the mean quality score can vary from 1 to 10, it is apparent that little change in this score results from considering the turbidity effect. So it is reasonable to say that the variable has a small effect on site quality scores, a point which becomes more meaningful in a comparative sense. A relatively large change in the general mean is associated with the variable "highest point". A flat terrain should have a low beta value. Level 1 of highest point, has a beta value of -.926 associated with it; level 4 of highest point (the level indicates at least one feature projecting high above the water level) has a beta value of .412. When each of these scores is added to the general mean, the two values obtained are 5.241 and 6.167 respectively. Thus it is seen that the highest point variable has a much larger effect on site quality scores than the turbidity variable.

In contrast to the foregoing analysis techniques (in which regression coefficients or effects are calculated), the AID technique is a multivariate method of analysis used to classify data into homogeneous groups, called terminal clusters, on the basis of the value of a dependent variable. Given an interval value dependent variable and a specific set of nominal (possibly ordinal) independent variables, an AID analysis indicates (1) which independent variables may be considered to explain most of the variance in the dependent variable, and (2) which levels of independent variables account for the variance explained.

Two AID analyses were performed on the Wild Rivers data. The first run provided an analysis for the purpose of illustration only. The second, with the same number of degrees of freedom as ANOVA, was then performed to obtain AID results which are comparable to ANOVA results because both had the same number of degrees of freedom. (On comparing AID and ANOVA, see TN 20.) The R^2's were respectively .74 and .85. The former analysis produced fifteen terminal groups, the latter produced forty-five.

Figure 6 presents the results of the AID run which produced fifteen groups. The various steps of the analysis resulted in the tree diagram shown. The first step was to compute the mean site quality score of all 240 sites, in this case M = 6.17. This parent group, Group 1, is indicated by 1,240 at 6.17 on the site quality axis. The independent variable that accounts for the most variance in the dependent variable (site quality score) was then chosen.

Whenever AID is used, the independent variable that accounts for the most variance is chosen on the basis of variance explained in a dichotomous split. In this case the original 240 observations in Group 1 were divided into

ANOVA

Biological Factors

Estimated Parameter Values

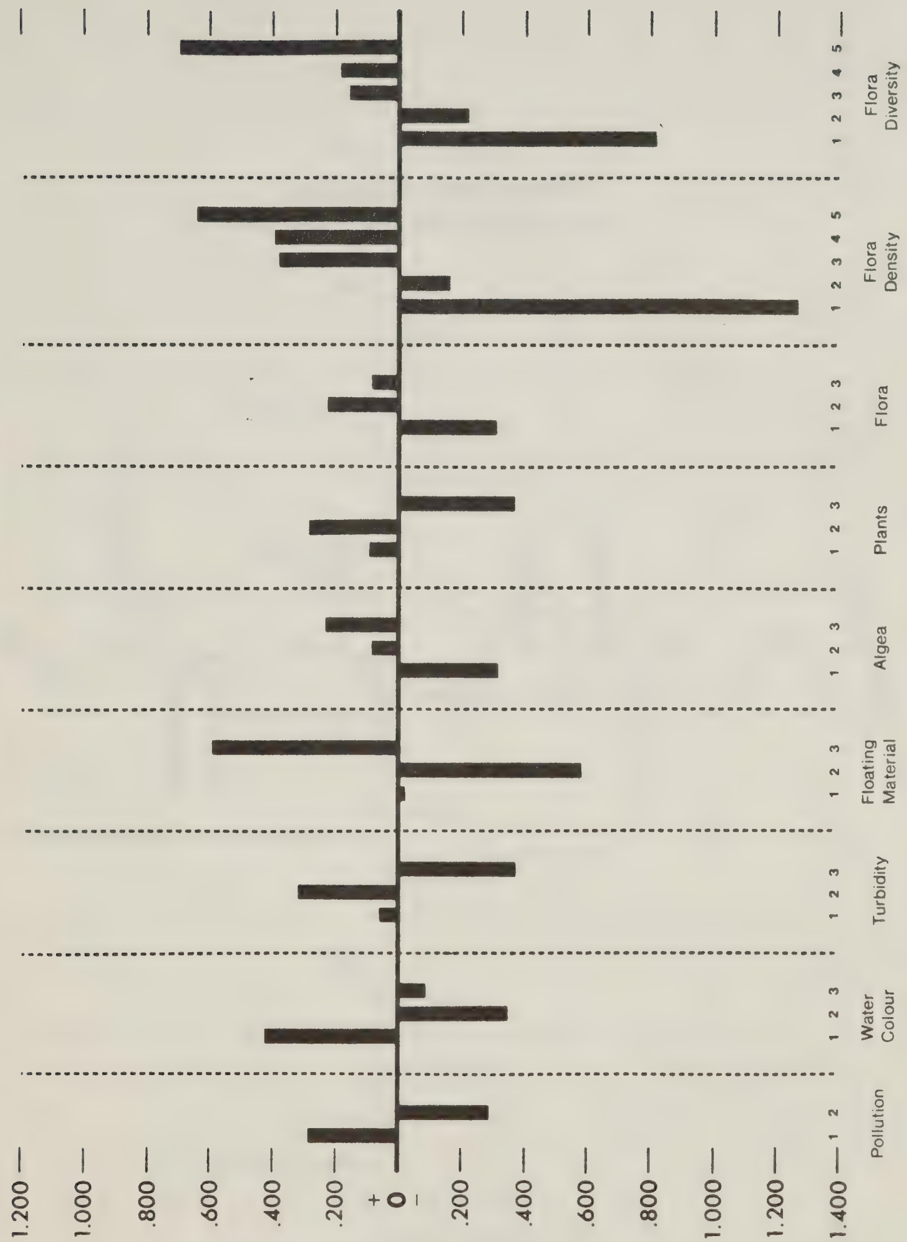


Figure 3

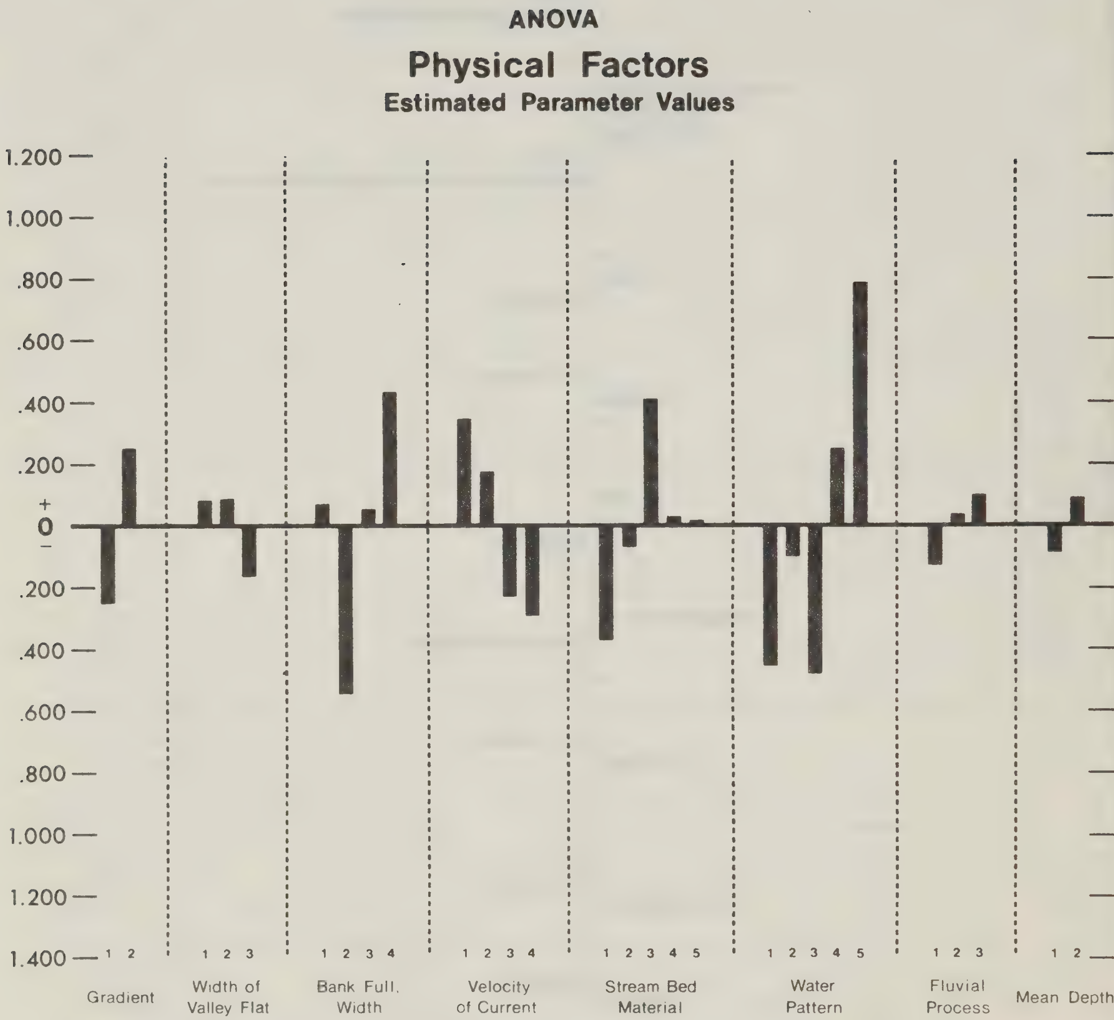

ANOVA
Physical Factors
Estimated Parameter Values
1.200
1.000
.800
.600
.400
.200
+
0
-
.200
.400
.600
.800
1.000
1.200
1.400
1 2
Gradient
1 2 3
Width of Valley Flat
1 2 3 4
Bank Full. Width
1 2 3 4
Velocity of Current
1 2 3 4 5
Stream Bed Material
1 2 3 4 5
Water Pattern
1 2 3
Fluvial Process
1 2
Mean Depth

Figure 4

ANOVA

Human Use and Interest Factors

Estimated Parameter Values

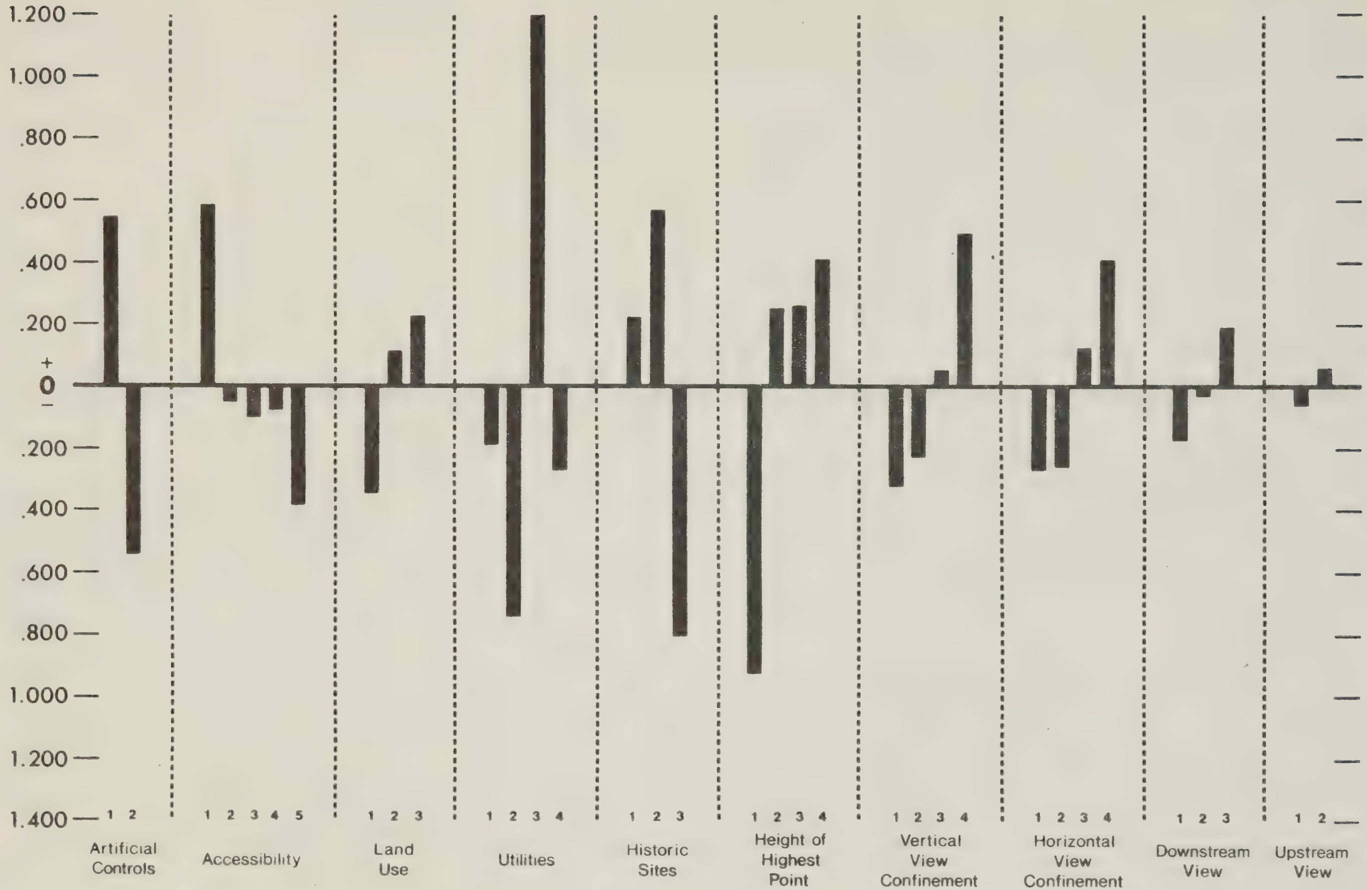


Figure 5

Groups 2 and 3 in such a way that there was the greatest possible difference between their site quality scores in terms of between-group variance. At the right-hand side of Figure 6, at splitting level 1, the independent variable "flora density" is shown because it accounts for the largest amount of variance in site quality scores. When Group 1 was divided on the basis of the flora density values, Groups 2 and 3 were formed. Group 2 contains observations with levels 2, 3, 4 and 5, of flora density and Group 3 contains level 1 (as indicated in the right-hand column of the Figure). The tree diagram is read from top to bottom. The brackets notation (X,Y) gives the variable on which a split has taken place to form Group X, which contains Y observations. By reading the X's, one may determine the order of splitting and thus, in some sense, the independent variables' relative power to explain variance. The position of the (X,Y) for a group on the site quality scale indicates the mean value of the dependent variable for the Group X. For example, as the Figure shows, Group 2 with a mean of 6.6 is made up of 187 of the original 240 observations.

When a further step of splitting is considered, the largest amount of variance within groups that may be split is taken as the criterion for selecting that group: the AID program computes the amount of variance (within each group that may be split) about the group mean. Referring again to Figure 6, since Group 2 has more variance to be explained than Group 3 (Groups 2 and 3 are the only candidates for splitting at step two), it is divided to form Groups 4 and 5 on the variable "water pattern". This splitting is done the same way as for Group 1: water pattern was the variable that would explain the most variance in Group 2 based on dividing the Group into two parts. Groups 3, 4 and 5 are now candidates for further splitting. Group 5, having the most variance to be explained, is split to form Groups 6 and 7 using the variable "water colour".

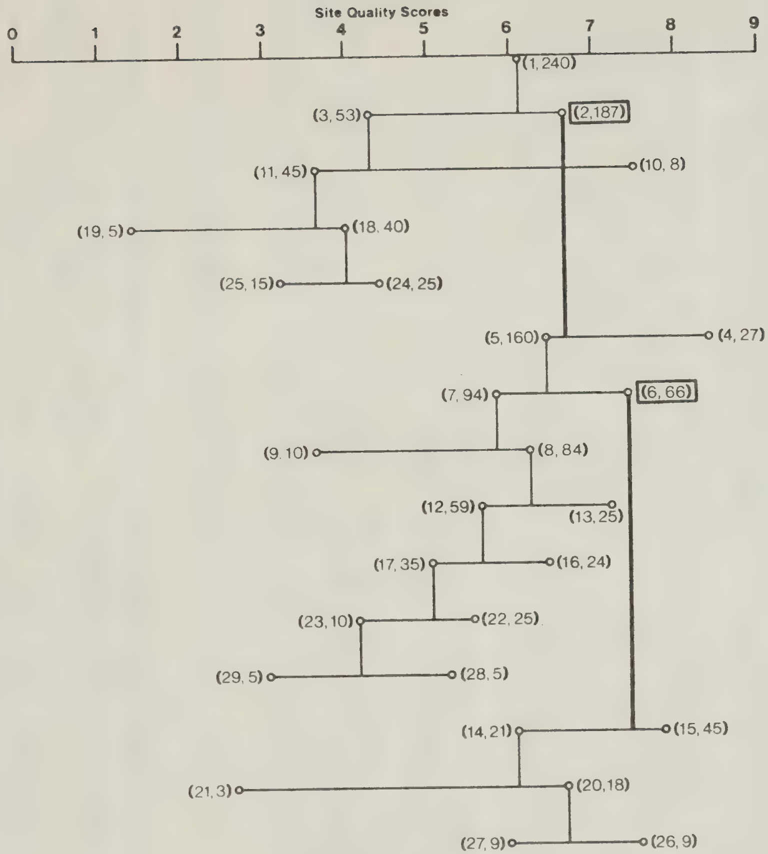
This process of splitting continues until a cut-off point is reached. These points are predetermined criteria that indicate that a particular Group available for splitting should not be split. Termination of splitting results in terminal groups. Group 4 underwent no further splitting because of the cut-off rule, and thus it is a terminal group. Other terminal groups are Groups 9, 10, 19, 22, etc. appearing at the ends of the branches of the AID tree. (For details, see TN 4.)

An AID analysis of the Wild Rivers data produced Group 19, which has the lowest site quality score (1.4) in the AID tree, and Group 4 which has the highest score (8.3). These two sites had a similar water pattern of torrent or waterfall (X25 = 5) but the variable "flora density" made the difference of scores of 1.4 and 8.3 on the site quality scale. Group 19 has a thin flora density while Group 4 has denser flora. Otherwise the sites in clusters 4 and 19 are similar.

Figure 6 also indicates that fourteen of the twenty-seven indepencent variables were significant in the

ANOVA

A. I. D. Tree Structure



Splitting Variable	Splitting Groups
Flora Density	X_{60} = (1), (2, 3, 4, 5)
Turbidity	X_{52} = (1, 3), (2)
Water Pattern	X_{25} = (5), (1, 2, 3, 4)
Water Colour	X_{51} = (2, 3), (1)
Water Pattern	X_{25} = (1, 2, 3, 4), (5)
Water Colour	X_{51} = (2, 3), (1)
Pollution Evidence	X_{50} = (2), (1)
Gradient	X_{12} = (1), (2)
Stream Bed Material	X_{24} = (1, 2, 3, 4), (5)
Plants	X_{55} = (1), (2, 3)
Stream Bed Material	X_{24} = (1, 2), (3, 4)
Height of Highest Point	X_{37} = (1), (3, 4, 5)
Flora Diversity	X_{61} = (1), (2, 3, 4, 5)
Accessibility	X_{30} = (2, 3, 4), (1, 5)

Figure 6

assessment of site quality in that they were used in forming the AID tree. Furthermore, because of its position on the tree, flora density may be considered a more prominent variable than turbidity. To the extent that the canoeists' aesthetic judgment is simulated by the AID trees, an understanding of the elements of the decision-making process is achieved and the AID tree lays out the logic behind the canoeists' definition of site quality. For this reason, the AID computer analysis may be said to replicate the tree of logic that a conoeist follows in defining site quality on wild rivers.

DISCUSSION

Earlier, it was pointed out that only interval variables having a logical bearing on landscape preference were used in the simple linear regression analysis. It was found that the interval variable of the linear regression model could be used to describe a linear relationship significant at the .005 level and explaining 38 percent of the variance in the Wild River data. On the other hand, with the ANOVA model, it was found that allowing for a curvilinear relationship and for the inclusion of nominal variables explained 59 percent of the variance in the site ratings.

In both models, the fourteen and twenty-nine parameters were estimated from 241 observations. Since the simple linear model has an R^2 of .38 and ANOVA is a generalization of the linear model, the ANOVA analysis has a larger R^2, as expected. This R^2 of .59 indicates that by introducing fifteen new parameters, 34 percent of the residual variance was accounted for:

$$(R^2(\text{ANOVA}) - R^2(\text{LINEAR}))/(1 - R^2(\text{LINEAR})) \times 100\%$$
$$= (.58 - .38)/(1 - .38) \times 100\% = 34\%$$

But is the increase in R^2 only due to increasing the number of parameters estimated? The percent of the remaining variance that can be expected to be explained by chance is $15/(241-14) = .066$ (about 7%), which is:

$$\%\ \text{of variance expected to be explained by chance} = \frac{\text{No. of degrees of freedom introduced to explain remaining variance}}{\text{No. of degrees of freedom of variance that remains to be explained}}$$

So the inclusion of an additional fifteen parameters would be expected to explain approximately 7 percent of the remaining variance by chance rather than the 34 percent actually explained. But this could still occur by chance, and so an F-test is useful to determine whether the increase

in variance explained is statistically significant. An appropriate F-ratio to test the significance of the increased variance explained is:

F = (1/(B - A)(SSE(ANOVA) - SSE(LINEAR)))/((1/(241 - B)) RSS(ANOVA)) = 7.12

WHERE

A = degrees of freedom in a linear regression model

B = degrees of freedom in an ANOVA model

SSE = the sum of the squared deviations around the mean of the site quality score explained by a model

RSS = the sum of the squared deviations around the mean not explained by a model.

The F-value 7.21 is significant at the .01 level. Allowing for nonlinearity by the inclusion of the fifteen nominal variables in the analysis results in an explanatory power significantly higher than chance would produce.

To summarize the preceeding discussion shows that one model may appear to be better than another because (1) it has more freedom to fit the same data, or (2) the better fit has occurred only by chance. The first condition is caused when a large number of parameters are estimated: the second is the result of random error. But, the 34 percent increase in explanation when more parameters were introduced is (statistically) significantly higher than the 7 percent increase that would be expected by chance, and so both (1) and (2) can be rejected as explanation and the ANOVA model must be accepted as better (more structurally appropriate to the data) than the simple regression model.

Similar consideration must be introduced in comparing AID and ANOVA, but one interesting difference exists. The AID model can be (and was) set up in such a way that it had the same number of parameters as the ANOVA model. Using the equation for increased variance explained, it is evident that the AID model explained the 63 percent that was not explained using the ANOVA model:

$(R^2(\text{AID}) - R^2(\text{ANOVA}))/(1 - R^2(\text{ANOVA}) \times 100\%$
$= (.85 - .59)/(1 - .59) \times 100\% = 63\%$

If, as before, one performs an F-test using the equation

F = (1/(B - A) SSE(AID) - SSE(ANOVA))/ (1/(241 - B) RSS(ANOVA))

a problem is encountered: the number of parameters in the AID model is equal to the number of parameters in the ANOVA model. Therefore 1/B-A involves division by zero. To avoid this problem B - A can be arbitrarily set to 1 (or even 2 or 3 if there is a desire to make the test very conservative). When this is done, the F-ratio is found to be 375.93, which

is significant at the .001 level with 1 and 212 degrees of freedom. (For other comparisons of AID and ANOVA results, refer to TN 20.) Thus the AID model fits the Wild River data better than do either the ANOVA or linear models. And this is true in a statistically highly significant way, predicting a given site's attractiveness for a certain purpose with more confidence than can be done with either of the other two models.

The results not only show that AID is the best model, ANOVA next and the simple linear poorest, but they confirm the conclusions of previous investigations and add a number of new dimensions. For example, the importance of vegetative cover in the evaluation of landscape photographs is also implied by the results obtained by Shafer (Reference 19), Rabinowitz and Coughlin (Reference 17), and Calvin et al (Reference 2). Further comparisons involve too elaborate a commentary to include here since the factors used in describing landscapes differ from one study to another.

Probably more important than confirmation of past findings is the fact that these studies allow researchers to say something about the structure of the decision made when a site is rated highly by a given individual. That the AID model (which puts the reaction of a site in the context of a collection of variables) is the most accurate model for describing the perceiver's decision-making process is proof that people do not react to individual resource variables and then build some total score for a site. Acknowledging the superiority of the AID model in explaining site attractions adds a meaningful dimension to the study of site attractivity. (Cesario used it to study park attractions in TN 4.)

To elaborate on the methodological complications of the preceding, there is often not enough care taken in distinguishing different uses of general programs such as the AID Program or regression programs. For example, it is perfectly valid to use a linear regression program to obtain the coefficients (parameters) that define a linear function, regardless of the number of data points, as long as that function is truly linear. Similarly, examination of the clusters determined by the AID Program tells us something about how the decisions that ranked various sites were made by the canoeists, even though only 240 observations were used. Group 11, for example, consisting of forty-five observations, was split to form two groups with means 1.4 and 4.0. In this case it is claimed that the groups formed are relatively homogeneous clusters having truly different site quality scores. Some may argue that is not statistically sound to use AID analsis to split a group containing forty-five out of 240 observations. However, further statistical examination indicates that a real structure has been found in the data: there is a difference of almost three units between the means of the two newly formed groups and there is a very low probability that this occurred by chance.

Some of the final splits presented in the paper make it

questionable whether anything new was learned about the rankings of sites. It is felt here that researchers need not be bound by criteria that suggest that either information must be available on 2,000 sites or AID must not be used. The important point is that if a researcher decides not to use AID simply because of a relatatively small sample size, and uses some linear technique such as ANOVA to look for structure, he may find it with an R^2 of .64 which looks good. But suppose that the reason for obtaining the model is to use it in making predictions in a planning exercise? Even an R^2 of .84 is not particularly good if one is to put much faith in predictions. What is worse is that if the structure of a model is not really appropriate to the data (as would be the case with the ANOVA) predictions will be systematically in error so that some types of good locations may be regularly underrated and bad ones overrated. Even if an analysis is used for strictly academic ends (except for teaching purposes) it is futile to derive a simple regression of an ANOVA model to explain data when these models are not appropriate.

In sum, the superiority of the AID analysis means that interactions between resources must be taken into account when formulating models to explain the ratings of the Wild River Sites considered.

CONCLUSION

Accepting the straightforward conclusion reached (that the AID model is superior to the other models considered for explaining perceived quality of sites) and if other research supports these findings, then interaction must be considered in developing meaningful models of how people react to their environment in terms of assessing the attractiveness of a given setting. But even the preceding statement fails to emphasize the importance of quality or attractiveness "to whom and for what purpose." It is unlikely that a wild river canoeist will rate a site highly if the river has little gradient: he will prefer the excitement of changing water conditions. A fisherman who uses a motorboat, on the other hand, may prefer a river without barriers. Thus there may be homogeneity of response among wild river canoeists and large variations across different river users. An individual's reasons for being at a certain site determine to some extent the rating of the site in terms of scenic value and there is no suggestion here that the ratings by the canoeists are generalizable to a population of river users.

This has clear implications for park planners. Within a parks planning framework, concern is with whether a site quality measure defined by field survey crews can be explained by resource variables for the sites studied (e.g. natural, cultural, etc.). If site quality can be explained with a high enough degree of accuracy by a function of a number of resource variables, it is possible to predict the quality of various areas by using only resource information.

The AID model can be used for predictions (see TN 4) and an R^2 of .84 suggests that they would be quite good. Thus at first sight it appears that there are planning applications of the AID model worth investigating, particularly so in an era when remote recording techniques can be used to produce relatively inexpensive resource data that can be readily processed by computers.

The "catch" is that the model derived gives quality estimates for a particular type of user at a site for a particular purpose. Quality values for a number of types of users could, of course, be computed but unless there is almost total agreement between quality measures there is the problem of how to get an overall intangible assessment. (See TN 25.) Unfortunately a compromise quality may not satisfy any of the users of a site. So, it must seriously be asked if it is only engineering type assessments (for example, impact on land due to use) that are worth generating using computers.

Certainly some of the modelling techniques now in vogue for capacity and impact analysis (ones which involve people stating their model for the social capacity of an area) are brought into serious question by the quantitative results presented here. An ANOVA model has been shown to be inappropriate to explain expert canoeists' perceptions of site qualities on wild rivers. Even if an ANOVA model were appropriate to assessing composite quality to a party that is at the site for purpose X, why should it be appropriate to explain the quality of day-use or camping areas? Why should one suppose that Mr. or Mrs. Average Citizen or park planners or managers are able to state the parameters of the model they are using to assess quality?

It is the policy-maker's responsibility to decide whether or not an agency's plans and policies for the management of a specific resource should reflect only current popular values and tastes or if (for example) they should focus on conservation or be used to mould future values by providing new environments, experiences, programs and facilities. Perceptual studies can be useful for marketing purposes, and can provide a basis for interpretive programs but they are not appropriate as the exclusive vehicle for planning analysis. In an age of increasing automation, it is important to realize that just because a model can be developed that explains 84 percent of the variance in site quality rating for one type of site for one type of user, that is no reason to suggest that a planner attuned to the objectives for a park is not a better "vehicle" to use in planning the park. The planner who sees merit in having the way he judges site qualities automated should exercise great care that (1) different models are developed in relation to sites having different purposes, and (2) that sohphisticated models like the AID model are used to reinforce planners' judgments in preference to ad hoc model formulations in which he specifies the importance of variables and their values and these are "plugged into" a preconstructed equation that may be entirely inappropriate

to the way he makes decisions. It must always be remembered that perceptions and preferences change. The planner must have the flexibility to handle this change and, at times, to influence it.

APPENDIX

ANALYSIS OF VARIANCE, VARIABLES, VALUES AND ESTIMATED ANOVA PARAMETER VALUES FOR ATTRACTIVITY

General Mean = 6.167

VARIABLE	LEVEL	BETA
Gradient(Rate of drop) Feet per Mile	1. 0 - 7	-0.252
	2. 8-132	0.252
Width of Valley Flat Feet	1. 1 - 1,295	0.081
	2. 1,296 - 9,999	0.002
	3. 10,000 - 31,999	-0.163
Bank, Full River Width - feet	1. 35 - 322	0.064
	2. 323 - 2,302	-0.547
	3. 2,303 - 8,834	0.048
	4. 8,835 - 9,999	0.435
Velocity of Current Feet per Second	1. 0 - 2	0.349
	2. 3 - 7	0.173
	3. 8 - 14	-0.231
	4. 15 - 80	-0.292
Stream Bed Material at Edge of River	1. Clay or silt	-0.372
	2. Organic sediment	-0.065
	3. Gravel	0.408
	4. Cobbles	0.020
	5. Rocks or Boulders	0.009
Water Pattern of River at Site	1. Smooth	-0.459
	2. Surges	-0.098
	3. Ripples	-0.480
	4. Chutes and rapids	0.248
	5. Torrent or waterfall	0.788
Fluvial Process at Site	1. Erosion	-0.126
	2. Erosion & Deposition	0.029
	3. Deposition	0.097
Artificial Controls	1. Free and Natural	0.545
	2. Present but unobtrusive or dam	-0.545
Accessibility	1. Trail, canoe, or plane	0.586
	2. *	-0.044
	3. Logging Road or shallow draught	-0.099
	4. *	-0.071
	5. Highway or Steamer	-0.381

Land Use	1. Wilderness	-0.348
	2. Pioneer Area	0.119
	3. Resource & Urban	0.229
Utilities (graded as to frequency)	1. None	-0.191
	2. Infrequent	-0.737
	3. unobtrusive	1.200
	4. Obstructed by utility	-0.271
Historic Sites (Buildings or Features)	1. None or Many	0.225
	2. Infrequent	0.577
	3. Unobtrusive or Many	-0.802
Height of Highest Point in Feet	1. 0 - 254	-0.926
	2. 255 - 898	0.253
	3. 899 - 2,498	0.261
	4. 2,499 - 9,950	0.412
Vertical View Confinement - Degrees	1. 0 - 2	-0.319
	2. 3 - 7	-0.225
	3. 8 - 23	0.049
	4. 24 - 90	0.410
Horizontal View Confinement - Degrees	1. 0 - 14	-0.270
	2. 15 - 79	-0.262
	3. 80 - 254	0.121
	4. 255 - 360	0.410
Downstream Visibility - Feet	1. 0 - 3,599	-0.171
	2. 3,600 - 29,583	-0.023
	3. 29,854 - 31,999	0.193
Upstream Visibility - Feet	1. 0 - 3,843	-0.055
	2. 3,844 - 31,999	0.055
Pollution (Evidence Perceived by Senses)	1. None	0.287
	2. Very Evident	-0.287
Water Colour of River Stie	1. Colourless or White	0.425
	2. Blue or Brown	-0.343
	3. Green	-0.082
Turbidity of River at Site	1. Clear	0.053
	2. Cloudy	0.320
	3. Turbid or Muddy	-0.372
Floating Material on River at Site	1. None	-0.014
	2. Vegetation and/or Oil	-0.582
	3. Foam	0.596
Algae at Site of River	1. Absent	-0.312
	2. *	0.081
	3. Infested	0.231

Plants at Site of River	1. Absent	0.086
	2. *	0.282
	3. Infested	-0.368
Flora Type of Woods	1. Tundra or Mix Woods	-0.310
	2. Spruce and Birch	0.228
	3. Conifers and Hardwood	0.082
Flora Density at Site	1. Thin	-1.265
	2. *	-0.160
	3. *	0.383
	4. *	0.398
	5. Dense	0.644
Flora Diversity at Site	1. Small	-0.819
	2. *	-0.222
	3. *	0.154
	4. *	0.185
	5. Great	0.701
Mean Depth at River Site - Feet	1. 1 - 7	-0.084
	2. 8 - 50	0.084

* Note: Some of the levels appear to be missing - these levels fall between the upper and lower level and are to be read on an intuitive level.

REVIEW

Gordon Ewing

The four papers in this chapter provide illustrations of the three basic ways in which destination attractiveness has been estimated in recreation literature and, for that matter, in a wider literature in geography. In the Juurand et al. paper on wild rivers, the estimate of a site's attractiveness is the average of subjects' stated attraction ratings. In Ross's paper on Attractivity Indices, a site's attraction is considered to be revealed through a subject's actual choices and rejections of that site when compared with alternative sites. Thus these two papers exemplify the distinction between a "stated degree of attractiveness" as opposed to what the economist calls "revealed preference" as the basis for estimating site attraction.

The third estimation method is illustrated by Cheung's method, discussed in TN 9 and 28 (see also TN 1), where a site's attraction is calculated from some concatenation of the site's score on several variables, each weighted according to its assumed importance in contributing to site attraction. The variables used to calculate attraction, the score assigned to a variable at a site and the weight assigned to that variable in contributing to attraction are all based to some degree on the researcher's or planner's subjective judgement, usually bolstered to some extent by background statistics, e.g. statistics on participation rates in different activities.

The three categories of estimation can be defined as based on subject behaviour (the Ross and Cesario methods), subject opinion (the Juurand et al. method), and researcher opinion (Cheung's method). And between the subject behaviour methods of estimation there is a subtle distinction which merits note. Ross's method explicitly includes information on the circumstances under which a site is not visited by a subject, as well as those under which it is visited, whereas Cesario's model considers only data on the number of times a site is visited.

As regards the three categories, it can be argued, in a similar vein to an argument in the Supply Analysis review (see Chapter IV) that each approach reflects a conscious trade-off between validity and reliability of site attraction estimates. The method based on researcher opinion has the advantage of being standardizable. Referring for example to Cheung's formula (Equation 1 in TN 9), S(e), the relative popularity rating of activity e, could be based on regional statistics indicating participation in that activity and in that sense a standardized set of S(e) values could be used for a region. R(m), the relative importance rating of facility m as it relates to a particular activity, although subjective, could be a value agreed to either nationally or regionally. Only Q(m), the quantity or quality score of facility m would be a measure dependent on the

local field worker. Consequently, the test-retest reliability of the attractiveness measures so derived could be relatively high if computations were standardized. However, the validity of the measure must be in doubt if it is argued that not all the variables relevant to people's perception of site attractiveness have been included in the calculation, or if coefficients or the way they are concatenated do not accurately reflect the way users estimate site attractiveness.

Juurand et al.'s paper moves a step closer to satisfying the reservations raised above by estimating site attractiveness from statements of a sample of users. But, whilst their ratings are likely to contain more valid information about the true attractiveness of a site (since the users themselves are being polled) the test-retest reliability of the results will depend on having a sufficiently large sample, as well as depending on the ability to find a similarly stratified sample for each site. Inevitably, reliability is difficult (but not impossible) to achieve using this method.

The validity of expecting a subject to be able to give figures which accurately reflect the relative attractiveness of various sites to him has often been questioned. Given that attractiveness is an abstract notion and that people do not necessarily "know" their subconscious evaluations of things, any statement from a subject about his inner feelings has an unknowable level of validity. The problem is well summarized by Bertrand Russell (Analysis of Mind, 1921) when he says that:

> The discovery of our own motives can only be made by the same process by which we discover other people's, namely the process of observing our actions and inferring the desire which would prompt them.

This argument provides the philosophical basis for the paper Ross as well as Cesario's model, described in TN 9 and 28. Both researchers use information on actual recreation trips to infer estimates of site attractiveness, obviating the dependence on stated preference information. In principle such data are likely to produce valid attractiveness estimates since people's behaviour is presumably an external reflection of what they actually think about sites rather than what they say they think of sites. In practice, as will be argued below, there are certain problems in the methods used by Cesario and Ross which raise questions about the validity of these particular attractiveness estimation procedures. Moreover, the reliablility of the estimates obtained is statistically undefined in the sense that it is not clear to what extent sampling from a different distribution of origins would affect the estimates of destination attractiveness.

Turning to the individual papers, Ross provided a good example of an innovative attempt to extract site

attractiveness information from consumer behavioural data without having to make assumptions about what variables affect site attraction. This contrasts with trip distribution modelling which until recently had to exogenously define surrogates of destination attraction. For example, size of destination was often used as such a surrogate in shopping trip and migration studies. Ross, by contrast, directly estimates attractiveness without having to assume it to be related to specific site variables.

The basis of the estimation procedure is that if more distant site j is visited rather than a closer site k, site j is inferred to be more attractive than k; otherwise why would the extra distance have been incurred to visit j rather than k? The number of times j is inferred to be more attractive than k (C(j,k) relative to the number of times k is inferred to be more attractive than j (C(k,j)) is the basis of subsequent site attractiveness estimates. However, spatial bias in the origin locations of respondents can bias the above figures. Specifically if there are fewer subjects for whom k is the further of the two sites than there are subjects for whom j is the further, then, ceteris paribus, the odds are in favour of C(k,j) being less than C(j,k), since there are fewer people who choose k as a more distant destination than j, compared to the number who can choose j as a more distant destination than k. However, in practice this biasing effect can be removed, and has been in subsequent uses of Ross's procedure, by calculating:

$$(1)\quad P(j,k) = \frac{C(j,k)/N(j,k)}{(C(j,k)/N(j,k)) + (C(k,j)/N(k,j))}$$

WHERE

P(j,k) = the proportion of times site j is inferred to be more attractive than site k;

C(j,k) = the number of times j is chosen by subjects whose origins are further from j than from k; and

N(j,k) = the number of subjects whose origins are further from j than from k.

RATHER THAN:

$$(2)\quad P(j,k) = C(j,k)/(C(j,k) + C(k,j))$$

A second, more subtle spatial bias in origin locations can also affect the estimate of P(j,k) and hence the attractiveness estimates of j and k. Consider only the set of origins, i, of subjects who visited site j or k, and divide the pairs of D(i,j) and D(i,k) measures into two groups. Group 1 contains all D(i,j) and their associated D(i,j) where the subject visited j when D(i,j) > D(i,k), and group 2 contains all D(i,j) and D(i,k) where the subject visited k when D(i,k) > D(i,j). If, to take an extreme example, the D(i,k)'s in the first group were only

marginally smaller than their associated $D(i,j)$'s we cannot tell how much less j would have been chosen and therefore how much $C(j,k)$ and $C(j,k/N(j,k)$ would decline if the $D(i,k)$'s in that group had been much less than the $D(i,j)$'s rather than just marginally less. But in general it is true that as $D(i,k)$ diminishes relative to $D(i,j)$, so $C(j,k)$ and $C(j,k)/N(j,k)$ also decline, unless j is infinitely more attractive than k. Therefore, one can conclude that the values of $C(j,k)$ and $C(k,j)$ are dependent on the distances to the further, but chosen, site compared to the nearer rejected sites. Only if these pairs of distances were similarly distributed for the group of subjects choosing j when it was the more distant site and for the group choosing k when it was the more distant site, would there be no spatial bias in the estimation of $P(j,k)$. Whilst this condition can be tested for, it is not clear that any practical remedial action can be taken to eliminate the effect. And if the condition is common, it may well have a serious effect on estimates of site attractiveness.

Furthermore the discussion above is based on the assumption that there are no inter-personal differences in users' perceptions of a park's attractiveness, other than random differences. If the park has different attractiveness to different users (close or far, young or old, rich or poor, weekend or weekday) then the aggregate measure derived, say, for day-users is a reflection of the composition of the stream of visitors that come to the site. Actually, a site's weekday attractiveness for closeby day-users may be high while its weekend attractivity may be nil unless users are under a time constraint! Attractiveness to whom, from where, visiting for what purpose must be a matter of major concern in future work.

From another perspective, given that the site attractiveness measures obtained by Ross are ordinal, problems arise in either explaining ordinal scores in terms of site variable scores or using ordinal attractiveness scores as part of a trip distribution modelling effort. In the former case, if the ordinal scores are assumed to have interval properties, a procedure with weak assumptions about the distributional characteristics of variables, such as the A.I.D. technique used in the paper on wild rivers, may be used to explain attractiveness scores in terms of site variables. In the case of trip distribution modelling, however, it would be difficult to justify the assumption of interval properties, in light of the strongly metric assumptions of most trip distribution models. As a consequence, it is probable that these attractiveness scores cannot be used for that purpose.

The papers by Beaman and Cheung are concerned with the variability of site attractiveness measures that results from using different estimation techniques. Beaman compares the results obtained by Cesario, Cheung and Ross for the same set of twelve Saskatchewan parks. In observing higher correlations between Cesario and Ross's results, the suggestion is made that attractiveness measures based on

behavioural data cannot help but include the influence of the surrounding area on the estimate of attractiveness of a particular park. By contrast, Cheung's measure clearly relates only to characteristics of the site in question. To test this hypothesis, a regression equation of the following form is solved:

(3) $T(c)/T(f) = C0 - C1A(c)$

WHERE

$T(c)$ = a park's attractiveness as estimated by Cheung;

$T(f)$ = the same park's attractiveness as estimated by Cesario; and

$A(c)$ = the number of alternative sites within 100 miles of the park under consideration.

A statistically significant R^2 = .30 is considered to support the above hypothesis and new estimates $\hat{T}(f)$, based on the above regression solution are obtained as follows:

(4) $\hat{T}(f) = T(c)/(27A(c) - 125)$

The fact that the correlation between $\hat{T}(f)$ and $T(f)$ turns out to be less than that between $T(c)$ and $T(f)$ occasions surprise and is left unexplained. However, it should be remarked that in Equation 4 for any particular value of $T(c)$, $\hat{T}(f)$ is a discontinuous function of $A(c)$. Specifically $\hat{T}(f)$ is a decreasing function of $A(c)$ and takes on negative values for values of $A(c)$ between 1 and 4, but takes on only positive values for $A(c) > 5$, although still a decreasing function of $A(c)$. The size of the discontinuity between $A(c) = 4$ and $A(c) = 5$ depends on the value of $T(c)$. This discontinuity may explain why the correlation between $\hat{T}(f)$ and $T(f)$ is poorer than between $T(f)$ and $T(c)$.

In Cheung's paper comparing his own and Cesario's park attractiveness estimates, the concern is to determine which set of estimates better predicts trip flow ($V(i,j)$). In Cesario's original paper, attractiveness estimates $A(j)$ were obtained by calibrating a model of the form:

(5) $V(i,j) = KE(i)A(j)f(C(i,j))e(i,j)$

where the terms are as defined in Equation 4 of Cheung's paper. Cheung then takes the $A(j)$ estimates obtained in one particularly specified model and uses them as an independent variable to predict $V(i,j)$ in three models specified quite differently from Equation 5 (see Equations 8a, 9a and 10a in Cheung's paper). He offers no explanation for having done so, and the transplantation should be examined closely. For example, if Cesario's original equation was properly specified and the others improperly, then it would be clearly invalid to say the $A(j)$ estimates performed poorly in terms of predicting $V(i,j)$ by testing their performance

in an improperly specified equation. If, on the other hand, Cesario's equation was not properly specified, it is difficult to see what can be proven by taking his estimates from that equation and testing their predictive ability in what may just as well be another improperly specified model. In general, it is invalid to take estimates of A(j) obtained in one equation predicting a given variable, in this case V(i,j) and to test the predictive ability of the same A(j) estimates in a differently structured equation with the same dependent variable, V(i,j). Therefore, any inferences made from comparisons of the predictive abilities of Cheung's and Cesario's attractiveness estimates are of doubtful validity.

Scrutiny of the least-squares estimates in regression Equations 8 through 10a in Cheung's paper also raises the question of whether the standardized regression coefficients in each pair of equations are statistically significantly different. Certainly the unstandardized coefficients provided in Tables 2 through 7 are remarkably similar, except where the scale of magnitude of T(c) values relative to T(f) values affects their regression coefficient values (Cheung identifies Cesario's A(j) estimates as T(f) and his own as T(c)). In addition, it is really only in Equations 10 and 10a that the independent effects of T(c) and T(f) can be judged. In Equations 8 and 8a the explanation of variance in V(i,j) is dominated by the effect of origin population (P(i), and T(f)/g(D(i,j)) and T(c)/g(D(i,j)) contribute only .4% and .2% respectively to the total variance explained. In Equations 9 and 9a the independent variables both have distance components embedded within them, so that it is impossible to tell how much of the 68.6% of variance in V(i,j)/Pop(i) explained by T(f)/g(D(i,j)) is attributable to g(D(i,j)) and how much to T(f). Only in Equations 10 and 10a are the independent effects of log T(c) and log T(f) on log (V(i,j)/Pop(i)) measurable and it is notable that in both equations, log D(i,j) dominates in explaining 64% of variance and log T(c) and log T(f) explain only .2% and 1.1% of variance respectively. This suggests that in Equations 9 and 9a perhaps g(D(i,j)) is the main explanatory variable and that the t(c) and T(f) terms have only a small random effect on the level of prediction of V(i,j)/Pop(i).

It is difficult to conclude from the above either that T(f) and T(c) have any appreciable effect on the variance of the three dependent variables or that the small influence they may have differs markedly between T(f) and T(c). Given this and the question of whether the procedure used to test the predictive ability of the T(f) values is valid, one is led to conclude that nothing meaningful has been said about the relative predictive capacities of the Cheung and Cesario attractiveness measures.

Turning to the question of whether there is any effective way to compare the predictive abilities of two differently derived sets of attractiveness scores, it is difficult to see how an effective comparison could be made in this case. Cesario's set of estimates are parameters estimated by fitting an equation to the very interaction

data to be predicted, whilst Cheung's estimates have much less flexibility in the sense that they are based on a predetermined formula with no free parameters. It would therefore be invalid to take Cheung's T(c) values and use them in Cesario's model (Equation 5) since there would be fewer free parameters in this case than in Cesario's case where the T(f) values are free parameters to be estimated. The conclusion is that it is perhaps a vain oversimplification to hope to make direct comparisons of this kind, where the estimating procedures are so radically different.

The final paper in Chapter III on the perception of the quality of wild rivers, unlike the others, is not so much concerned with methods of estimating site attractiveness as with the explanation of these estimates, however obtained, in terms of site characteristics. In particular, it illustrates three different mathematical models which explain perceived site attractiveness scores in terms of perceived site characteristics. The less rigid the assumptions of the model, the more variance in the dependent variable is explained. The multiple regression model assumes the dependent variable to be a linear and additive function of the independent site characteristic variables and achieves an R^2 of .38. By contrast, a generalized analysis of variance model, though additive, allows independent variables to be defined categorically rather than continuously and obtain an R^2 of .59. Finally, A.I.D. with the added facility of allowing interaction effects between independent variables, gives an R^2 of 0.84. The latter would seem particularly useful for planning in cases where as weak assumptions as possible must be made about data, and where subtle relationships between variables are thought to exist. Inevitably the price of this greater flexibility is a reduction in the ease of interpreting results in the form of an A.I.D. tree diagram.

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CHAPTER IV

ORIGIN MODELS

INTRODUCTION

Knetsch, in line with his general plan for the CORD Study (see Chapter 1), suggested that work done by Cicchetti, Seneca and Davidson in the United States should form the basis of a procedure for analyzing CORD Study National Survey data collected on the level of peoples participation in outdoor activities. However, after some preliminary work, this analysis approach was not used because examination of data indicated that this kind of analysis simply could not be carried out in 1971 because of the need for certain accurate supply information. Instead, a proposal by Hendry (see Reference 8) for a "dummy variable analysis" of the National Survey data was pursued, so as to allow the socio-economic variable effects on participation to be calculated, even though some of those variables were nominal. TN 12, "Analysis of Variance as a Tool for Estimating Participation in Outdoor Recreation Activities" presents the version of the model proposed by Hendry that was eventually used. It goes beyond calculating "effects" of variables by describing procedures for estimating the number of people that a city will generate as participants in a given activity, and indicates how parameters calculated on the basis of behaviour reported in a National Survey can be used to estimate the amount of participation in, for example, hunting in Quebec.

However, when estimates are made using the model proposed, questions arise about the validity of procedures proposed for the use of Analysis of Variance in estimating participation in outdoor activities. Some of these questions relate to three considerations: (1) the effect of supply on participation, (2) the accuracy of estimates made, and (3) the structural deficiencies of models developed. Issues related to supply influences are taken up in the chapter on Supply Analysis. In this chapter there are papers on the accuracy of estimates of participation and structural deficiencies of models. Matters not raised above are numerous. For example there has been concern about the accuracy of origin models related to the low magnitude of R^2 found when models are parameterized. This topic and some related concerns are taken up in TN 36 in Chapter VII.

Other problems relate to the stability of model coefficients over time. TN 13, in Chapter IX, deals specifically with projections. In it the author sets up a "context of validity" for the projection procedure described in TN 12 and thus further clarifies methodological issues related to using origin models.

ANALYSIS OF VARIANCE AS A TOOL FOR ESTIMATING PARTICIPATION IN OUTDOOR RECREATION ACTIVITIES

S. Rousseau, J. Beaman, M. Renoux, J. Hendry

ABSTRACT

The use of analysis of variance in attempting to arrive at an understanding of participation in outdoor recreation is probably best known from the its use in the Mueller and Gurin volume of the ORRRC report. There the authors discussed how the estimated effects of socio-economic characteristics on people's participation provided insight into recreational behaviour that could not have been obtained by merely tabulating data.

This paper goes beyond that and deals with applying analysis of variance to data pertaining to a certain recreation activity to estimate participation in that activity by people in a given geographic area, conditional on the socio-economic characteristics of these people.

Specific formulae for making estimates are given in the paper and their use is illustrated by making predictions of the number of hunters and total hunting trips by Quebec residents.

The paper concludes with a discussion pointing out some difficulties encountered in using the methods of estimation described. The resons for having alternative methods for estimating total volume of activity (total hunting trips) is an important topic taken up in this section of the paper.

There are references in the paper to a number of papers in which further results such as (1) when such a model should be used. (2) accuracy of results, (3) structural problems with the models derived, and (4) the value of R^2 should have, have been presented.

INTRODUCTION

As early as 1961 there was a paper produced which presented the results of analysis of variance on how having different levels of income or belonging to a particular socio-economic category influenced a person's participation in outdoor activities. In that study by Mueller and Gurin (see Reference 9), the authors went so far as to recognize that the same model of how participation related to socio-economic variables was not appropriate for both males and females because of what are known as interaction effects. Other work has influenced the production of the models

presented here. From within the CORD Study, one influence was the proposal by Hendry (see Reference 8) that CORD Study National Survey data should be processed by a dummy variable analysis; this is the economists way of saying that a variant of the kind of analysis described here should be undertaken. Knetsch also made a proposal that CORD Study national survey analysis should follow a strategy that was laid out by Chiccetti, Seneca and Davidson. (See Chapter I.) So, in the history of recreation research and in the history of the CORD Study there are suggestions that a model that may be expressed in words as follows should be used in analyzing people's outdoor recreation participation:

Equation 1 (Form 1):

Probability of participation or frequency of participation for a person with socio-economic characteristics	= a general participation level	+	Effect of being in a city, in a town or in in country	+	the effect of being a member of a certain size household + etc.

In mathematical terms the equation is:

$$Y(i,J,K,L, \ldots) = U+B(1,J)+B(2,K)+B(3,L)+\ldots+C(i)$$

WHERE $Y(\cdot)$ is 0 or 1 for participation or nonparticipation or for a frequency model is the actual number of times that a person participated; i, J, K, L, ..., the sub scripts of $Y(\cdot)$ give information about the person i who has level J of a first socio-economic variable (e.g. in Figure 1 comes from a household of some size), who has level L of a third socio-economic variable (e.g. education level), etc.

U is a general level that applies to all persons (from Table 1 for participation by male hunters for 1972^2 it is .234);

$B(1,J)$ is the effect on $Y(\cdot)$ of having level J of socio-economic variables 1 (under 1972^2 of Table 1, $B(1,2)$ = .006);

$B(2,K)$ is the effect on Y of having level K of socio-economic variables 2 (e.g. in Table 1 for household size for 1972 #(2) the effect is -.002);

$B(3,L)$ is the effect on Y of having level L of socio-economic variable 3;

$B(\cdot)$'s with first subscripts up to 9 would be necessary to define all the effects shown in Figure 1 and given in

Table 1 C(i) is an error term that has a value equal to the difference between the observed Y for person i and his predicted i (this is illustrated subsequently).

Having referred to Table 1 and Figure 1 it seems appropriate to give some general explanation about these and the related Tables 2 through 4 and Figure 2. These are from a larger document that was originally to be an appendix to TN 12, Rousseau's "appendix". The Table of Contents of this larger document, which was prepared by Rousseau, one of the authors of this paper, is now all that is included as an appendix.

In Rousseau's original "appendix", all results of the many possible first order effect analyses of peoples' participation and frequency of participation that could be carried out on National Survey Information that were available in 1974 were presented in figures and tables. In 1974 it was only possible to process 1969 and 1972 CORD Study national survey data. The 1969 data are for persons 18 years of age and over and the 1972 data are for people 10 years of age and over. Thus the three options arose of processing 1969 data, 1972 data for persons 18+, and 1972 data for 10+ to obtain the three somewhat different sets of coefficients shown in the figures and recorded in the tables as 1969, 1972^1 and 1972^2. Subsequently it has become possible to process CORD Study National Survey, 1967 data on peoples' participation in outdoor activities. But if one examines the results presented here on hunting participation and hunting frequency, one will note that there is generally good agreement between the 1969 and 1972 differentials for both models. So 1967 analyses have not been carried out because it was considered that the work involved in incorporating these data into the existing summary information would not be justified by any benefits that might be derived by showing the similarity of 67 results to those for 1969 and 1972.

As for the possibility of discerning a trend in the coefficients, one need only look at the standard deviations of the coefficients to see that one need have no great expectations that any kind of reliable trends in coefficients can be discerned based on the survey results available.

The preceding comments may have brought a particular matter of concern to the attention of some readers. What is the meaning, in some practical sense, of the table? Before there is any merit in being concerned about variation in these coefficients, obviously there must be a realization of what information the coefficients themselves put across. To see specifically what the coefficients indicate, an example is useful. Assume one wants to predict the probability of being a hunter in 1969 for a person who in 1969 was (1) male, (2) from a city of over 100,000, (3) married, (4) from a family of size three or four, (5) with some highschool education, (6) in the age group 30 to 39, (7) with an income

TABLE 1

ESTIMATED PARAMETER VALUES FOR HUNTING PARTICIPATION

General means for Males		General means for Females	
1969	.219	1969	.035
1972(1)	.216	1972(1)	.017
1972(2)	.234	1972(2)	.022

Beta No.	Labels	EFFECTS FOR MALES 1969	1972(1)	1972(2)	EFFECTS FOR FEMALES 1969	1972(1)	1972(2)
CITY SIZE							
B (1,1)	Over 100,000	-.091	-.126	-.144	-.015	-.026	-.030
B (1,2)	30,000-100,000	-.022	.018	.006	-.026	.006	-.002
B (1,3)	10,000-30,000	.012	.090	.077	.022	-.006	.005
B (1,4)	1,000-10,000	-.005	-.036	-.012	.005	.011	.013
B (1,5)	Rural	.106	.054	.074	.015	.014	.014
PERSONS IN HOUSEHOLD							
B (2,1)	One	.011	-.000	.008	.007	-.007	-.003
B (2,2)	Two	-.019	-.012	-.002	-.002	-.006	-.003
B (2,3)	Three or Four	.011	.025	.022	.004	-.011	-.006
B (2,4)	Five	-.009	-.025	-.029	-.008	.006	-.002
B (2,5)	Six or More	.006	.012	.001	-.002	.018	.014
EDUCATION							
B (3,1)	Public School, Refuse	.001	-.024	-.055	-.008	-.006	-.004
B (3,2)	Some High School	.016	.043	.064	.008	.007	.006
B (3,3)	High School Grad. or More	-.017	-.019	-.009	-.0002	-.002	-.003
AGE							
B (4,1)	10 to 17	-	-	.035	-	-	-.000
B (4,2)	18 to 29	.070	.067	.049	.034	.029	.027
B (4,3)	30 to 39	.011	.026	.014	-.012	-.013	-.011
B (4,4)	40 and Over	-.081	-.092	-.098	-.022	-.016	-.015
INCOME							
B (5,1)	Refuse, Don't Know	-.024	-.022	-.042	-.021	-.019	-.014
B (5,2)	Less than $2,999	-.059	-.043	-.033	-.006	.008	.006
B (5,3)	$3,000. to $5,999	-.006	-.006	.005	.005	-.017	-.020
B (5,4)	$6,000. to $10,499.	.072	.031	.038	.005	.004	.006
B (5,5)	$10,500. or More	.016	.039	.032	.017	.023	.021
MARITAL STATUS							
B (6,1)	Single	.007	.010	.010	-.003	.014	.015
B (6,2)	Married	.031	-.007	-.008	.001	-.012	-.013
B (6,3)	Other	-.038	-.004	-.002	.002	-.002	-.002
POSITION IN HOUSEHOLD							
B (7,1)	Head (Male or Female)	-.010	.034	.030	.003	.030	.028
B (7,2)	Son or Daughter	.012	.010	.009	.0004	-.002	.001
B (7,3)	Other	-.002	-.043	-.039	-.004	-.028	-.029
CHILDREN UNDER 5							
B (8,1)	None	-.016	.004	-.002	-.0005	.007	.004
B (8,2)	Some	.016	-.004	.002	.0005	-.007	-.004
HOUSING							
B (9,1)	Single	.012			-.011		
B (9,2)	Row, Duplex, Multi	.007			.012		
B (9,3)	Apartments	-.019			-.001		

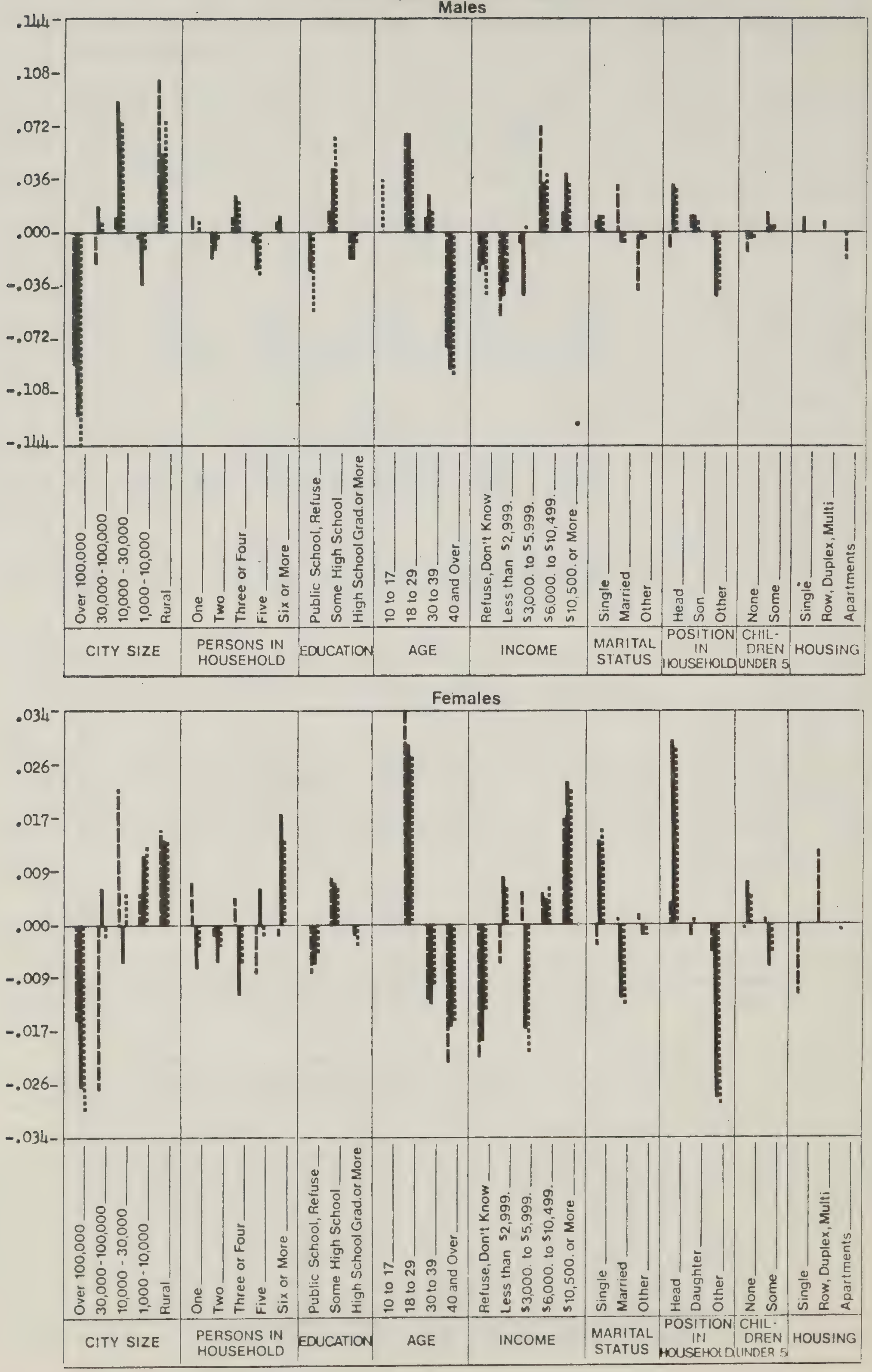
(1) 18 years of age and over

(2) 10 years of age and older

* The 1969 and 1972 Frequency figures are not comparable because frequency catagories are not identical for both years.

FIGURE 1

BETA VALUES FOR
HUNTING PARTICIPATION
IN 1969 - - , 1972 (1) — AND 1972 (2) ....



of $6,000 to $10,499 in 1969, (8) the head of the household, and (9) with no children under 5 at his home (10) which was a single family dwelling. To determine this probability based on the 1969 survey, one simply takes the general mean for males of .219 given in Table 1 and adds to it the relevant increments or beta values from the first column, the column under 1969 of Table 1, to obtain the equation below, which indicates that the probability of participating is .219 - .091 + .011 + .016 + .011 + .072 + .031 - .01 - .016 + .012 = .255

The coefficients in Table 3 can be used in the same way to get a prediction of the number of times that a similar male can be expected to go hunting.

The reason for presenting the results of the analysis graphically is that the large array of numbers in Table 1 does not give a quick impression of peoples' behaviour. The graphs of the regression coeffients show that (for hunting participation) there are fairly distinct trends both for males ana females. Negative differentials show the low probability of hunting, for people in large cities. One also sees the shift to positive differentials for people from small communities and rural areas. With age, once one passes the age 16 at which hunting is legal, one notes that there is a decrease in hunting participation with increasing age. This decrease in participation in an activity with increasing age is something that almost all activities have in common and which to some extent reflects a general tendency of most people to become less active when they become older. By looking at the coefficients on the relationship between participation and numbers of persons in the household, one sees that there are not strong effects compared to the age effects or city size effects.

Tables 2 and 4 present standard deviations values for the regression coefficients that are plotted in the graphs and which are reported in Tables 1 and 3. These standard deviations give one an idea of the size of deviation between the "true" coefficient and its estimate, which has a very high probability of occuring. If one can assume that the distribution of the coefficients is somewhat near normal, then the characteristics of the normal distribution suggest that deviations of about 1.56 times the standard deviations reported have a relatively low probability of occuring (less than 1 chance in 10). So for example, one may note that the hunting coefficient showing the decrease in probability of a - .091 that was observed for being in a city of 100,000 in 1969 has a standard deviation of .02. This means that there is a high probability that this coefficient could be as large as .11 or as small as .071 but, in line with the point just made, the probability that it will be greater than .12 or less than .06 is quite remote. In the case of the coefficients that apply to the number of persons in the household, one may observe that all of these have an absolute value of under .02 whereas all of the standard deviations for these coefficients are over .02; this is a clear indication that one can accept the hypothesis that all

of these coefficients equal zero: in other words that persons in the household need not be a variable considered in predicting hunting participation.

Given the previous statements, it seemed rather awkward to go back and indicate that the coefficients were not computed in the most efficient way possible and that the variance estimates may be larger than they should be. The point is that there are a number rather tricky statistical issues related to the need to carry out special weighted regressions. As indicated in the Review of Chapter VII, carrying out these special regressions would have resulted in additional expense that was unnecessary because with the number of observations available. Weighted regression apparently does not produce parameters that are perceptably more accurate than an unweighted analysest Also other work showed that the models developed had other problems. Results presented in TN 20 show that the kinds of simple models presented here very often explain only about half the variance that should be explained by socio-economic characteristics. This is because the simple autonomous effects of socio-economic variables assumed to apply here are not complicated enough to mirror reality. However, the method is still appropriate to making predictions with a more complicated model, so there is merit in presenting the method and noting its problems.

The reader may note that a hunting model is tested in Technical Note 6 and is accepted to be structurally appropriate to the 1972 data on male residents of Canada's participation in the activity hunting obtained in the 1972 National Survey of Canadians' participation in outdoor activities. In that same note it is explained why results derived in TN 29 show that the hunting model derived here is not good because the effect of supply in participation is not considered. In the next section of this paper the rationale behind using an equation such as the one introduced in making predictions is presented. But the accuracy of the predictions that can be made using such a model are taken up in a separate paper (TN 6). As already implied, structural problems with the equation (in terms of using it in modelling people's behaviour) are taken up in several other papers. The matter of whether or not interaction effects exist and their magnitude is the topic of TN 20. TN 29 deals with the matter of whether the effect of supply can and/or should be incorporated into Equation 1. TN 35 presents the results of research on what the value of R-squared should have when regression is carried out on survey data to estimate the parameters of Equation 1 (form 2) and how one can test for model validity. (See also the Review of Chapter 7 of this volume).

In the way of further introduction, the reader may find it interesting to note that the present version of TN 12 is not the original version which was released. A great deal of work on applying the analysis of variance model for making predications has been carried out by Renoux, 1973, 1975 (see Reference 11, 12). The CORD Study research, cited above has

TABLE 2

STANDARD DEVIATIONS OF

ESTIMATED PARAMETER VALUES FOR HUNTING PARTICIPATION

General means for Males		General means for Females	
1969	.038	1969	.013
1972(1)	.030	1972(1)	.013
1972(2)	.028	1972(2)	.012

Beta No	Labels	Males 1969	Males 1972(1)	Males 1972(2)	Females 1969	Females 1972(1)	Females 1972(2)
CITY SIZE							
B (1,1)	Over 100 000	.020	.019	.016	.008	.008	.007
B (1,2)	30 000-100,000	.033	.030	.025	.012	.012	.012
B (1,3)	10,000-30 000	.036	.034	.030	.015	.016	.014
B (1,4)	1,000-10,000	.029	.029	.024	.011	.012	.010
B (1,5)	Rural	.023	.021	.018	.009	.009	.008
PERSONS IN HOUSEHOLD							
B (2,1)	One	.054	.043	.044	.017	.016	.016
B (2,2)	Two	.025	.022	.021	.009	.009	.009
B (2,3)	Three or Four	.022	.020	.018	.008	.008	.007
B (2,4)	Five	.030	.029	.023	.011	.011	.010
B (2,5)	Six or More	.028	.027	.022	.010	.011	.010
EDUCATION							
B (3,1)	Public School, Refuse	.017	.017	.014	.007	.007	.006
B (3,2)	Some High School	.016	.015	.013	.006	.006	.006
B (3,3)	High School Grad or More	.017	.016	.015	.006	.006	.006
AGE							
B (4,1)	10 to 17	-	-	.027	-	-	.014
B (4,2)	18 to 29	.023	.021	.019	.008	.008	.008
B (4,3)	30 to 39	.021	.021	.026	.007	.008	.010
B (4,4)	40 and Over	.020	.019	.022	.007	.007	.009
INCOME							
B (5,1)	Refuse, Don't Know	.060	.033	.027	.021	.012	.011
B (5,2)	Less than $2 999	.031	.026	.025	.012	.011	.011
B (5,3)	$3 000 to $5,999	.024	.022	.019	.009	.009	.008
B (5,4)	$6 000 to $10,499	.023	.018	.015	.009	.008	.007
B (5,5)	$10,500 or More	.033	.024	.020	.012	.010	.009
MARITAL STATUS							
B (6,1)	Single	.035	.028	.029	.012	.013	.013
B (6,2)	Married	.035	.028	.028	.010	.010	.011
B (6,3)	Other	.041	.033	.034	.011	.010	.010
POSITION IN HOUSEHOLD							
B (7,1)	Head (Male or Female)	.041	.033	.034	.014	.015	.016
B (7,2)	Son or Daughter	.034	.030	.029	.015	.016	.014
B (7,3)	Other	.038	.037	.036	.014	.018	.016
CHILDREN UNDER 5							
B (8,1)	None	.017	.017	.014	.006	.006	.006
B (8,2)	Some	.017	.017	.014	.006	.006	.006
HOUSING							
B (9,1)	Single	.019			.007		
B (9,2)	Row, Duplex Multi	.023			.008		
B (9,3)	Apartments	.026			.010		

(1) 18 years of age and over

(2) 10 years of age and older

* The 1969 and 1972 Frequency figures are not comparable because frequency categories are not identical for both years.

TABLE 3

ESTIMATED PARAMETER VALUES FOR HUNTING FREQUENCY*

General means for Males		General means for Females	
1969	1.041	1969	.096
1972(1)	1.736	1972(1)	.093
1972(2)	1.861	1972(2)	.084

Beta No.	Labels	Males 1969	Males 1972(1)	Males 1972(2)	Females 1969	Females 1972(1)	Females 1972(2)
CITY SIZE							
B (1,1)	Over 100,000	-.406	-.978	-1.282	-.063	-.133	-.120
B (1,2)	30,000-100,000	-.276	-.065	-.014	-.086	.028	.014
B (1,3)	10,000-30,000	-.023	1.039	.689	.092	.114	.093
B (1,4)	1,000-10,000	.010	-.107	.119	.016	.005	.010
B (1,5)	Rural	.695	.112	.488	.042	-.014	.004
PERSONS IN HOUSEHOLD							
B (2,1)	One	.285	-.164	.012	.032	-.051	-.036
B (2,2)	Two	-.051	-.300	-.116	-.006	-.016	-.005
B (2,3)	Three or Four	-.075	-.064	.093	.024	-.050	-.027
B (2,4)	Five	-.150	.339	.075	-.019	.055	.043
B (2,5)	Six or More	-.009	.190	-.065	-.032	-.002	.024
EDUCATION							
B (3,1)	Public School, Refuse	-.033	-.167	-.507	.003	-.018	.008
B (3,2)	Some High School	.198	.272	.487	.020	.040	.023
B (3,3)	High School Grad. or More	-.166	-.105	.020	-.024	-.021	-.031
AGE							
B (4,1)	10 to 17	--	--	.457	--	--	-.014
B (4,2)	18 to 29	.682	.453	.207	.107	.124	.125
B (4,3)	30 to 39	-.227	.323	.172	-.023	-.054	-.041
B (4,4)	40 and Over	-.455	-.776	-.836	-.085	-.070	-.069
INCOME							
B (5,1)	Refuse, Don't Know	.266	.039	-.357	-.058	-.026	-.034
B (5,2)	Less than $2,999.	-.370	-.276	-.154	-.029	.006	-.009
B (5,3)	$3,000. to $5,999.	-.067	-.073	.096	-.002	-.040	-.049
B (5,4)	$6,000 to $10,499.	.080	.052	.259	.046	-.008	.009
B (5,5)	$10,500. or More	.092	.258	.156	.044	.069	.084
MARITAL STATUS							
B (6,1)	Single	.027	-.203	-.203	-.011	.067	.067
B (6,2)	Married	.275	.168	.129	.001	-.048	-.049
B (6,3)	Other	-.302	.035	.074	.009	-.019	-.018
POSITION IN HOUSEHOLD							
B (7,1)	Head (Male or Female)	-.022	-.035	-.056	.023	.120	.110
B (7,2)	Son or Daughter	.142	-.030	.078	-.013	-.026	-.012
B (7,3)	Other	-.119	.065	-.022	-.010	-.093	-.098
CHILDREN UNDER 5							
B (8,1)	None	-.124	.143	.046	-.001	-.001	-.002
B (8,2)	Some	.124	-.143	-.046	.001	.001	.002
HOUSING							
B (9,1)	Single	.129			-.017		
B (9,2)	Row, Duplex, Multi	.014			.028		
B (9,3)	Apartments	-.143			-.011		

(1) 18 years of age and over

(2) 10 years of age and older

* The 1969 and 1972 Frequency figures are not comparable because frequency catagories are not identical for both years.

TABLE 4

STANDARD DEVIATIONS OF
ESTIMATED PARAMETER VALUES FOR HUNTING FREQUENCY*

General means for Males		General means for Females	
1969	.253	1969	.048
1972(1)	.287	1972(1)	.061
1972(2)	.278	1972(2)	.055

Beta No.	Labels	Effects for Males 1969	Effects for Males 1972(1)	Effects for Males 1972(2)	Effects for Females 1969	Effects for Females 1972(1)	Effects for Females 1972(2)
CITY SIZE							
B (1,1)	Over 100,000	.131	.177	.157	.027	.035	.032
B (1,2)	30,000-100,000	.218	.283	.253	.042	.055	.053
B (1,3)	10,000-30,000	.238	.322	.297	.053	.071	.065
B (1,4)	1,000-10,000	.194	.272	.243	.039	.053	.047
B (1,5)	Rural	.155	.202	.180	.031	.041	.037
PERSONS IN HOUSEHOLD							
B (2,1)	One	.360	.409	.437	.061	.073	.073
B (2,2)	Two	.166	.207	.214	.032	.042	.042
B (2,3)	Three or Four	.143	.188	.180	.027	.036	.034
B (2,4)	Five	.197	.273	.233	.040	.050	.044
B (2,5)	Six or More	.182	.256	.220	.036	.049	.043
EDUCATION							
B (3,1)	Public School, Refuse	.115	.166	.140	.023	.033	.029
B (3,2)	Some High School	.106	.144	.127	.021	.028	.025
B (3,3)	High School Grad. or More	.114	.151	.154	.023	.029	.029
AGE							
B (4,1)	10 to 17	–	–	.274	–	–	.065
B (4,2)	18 to 29	.149	.200	.190	.029	.037	.036
B (4,3)	30 to 39	.142	.203	.256	.026	.036	.045
B (4,4)	40 and Over	.134	.184	.223	.026	.033	.042
INCOME							
B (5,1)	Refuse, Don't Know	.397	.312	.264	.075	.056	.050
B (5,2)	Less than $2,999	.205	.250	.244	.042	.052	.049
B (5,3)	$3,000 to $5,999	.157	.205	.186	.031	.039	.036
B (5,4)	$6,000 to $10,499	.152	.174	.152	.031	.034	.031
B (5,5)	$10,500 or More	.216	.224	.198	.044	.046	.041
MARITAL STATUS							
B (6,1)	Single	.232	.270	.287	.044	.058	.058
B (6,2)	Married	.234	.265	.284	.035	.048	.048
B (6,3)	Other	.270	.318	.341	.038	.046	.046
POSITION IN HOUSEHOLD							
B (7,1)	Head (Male or Female)	.269	.319	.339	.049	.070	.070
B (7,2)	Son or Daughter	.224	.287	.290	.053	.072	.065
B (7,3)	Other	.250	.356	.360	.052	.081	.074
CHILDREN UNDER 5							
B (8,1)	None	.112	.163	.137	.022	.028	.025
B (8,2)	Some	.112	.163	.137	.022	.028	.025
HOUSING							
B (9,1)	Single	.125			.025		
B (9,2)	Row, Duplex, Multi	.152			.029		
B (9,3)	Apartments	.171			.035		

(1) 18 years of age and over

(2) 10 years of age and older

* The 1969 and 1972 Frequency figures are not comparable because frequency catagories are not identical for both years.

occurred since the original TN 12 was prepared. This research has resulted in the recognition of a number of practical problems that are encountered in making computations which yield predictions and in the recognition of a number of theoretical problems. So a re-examination of the material resulted in the preparation of this present note and the revision of some other notes.

DEFINITION OF THE PROJECTION MODEL THEORY AND APPLICATION

Given the equations specified earlier as Equation 1, it is easy to see that for all of the individuals in a certain geographic area one could compute their probability of participating in a given activity or compute their frequency of participation in that given activity, as long as one knew the socio-economic characteristics of each individual or if it is only necessary to have certain census information. Visualize for the moment that one has an equation for each individual. Then, for example, for males one has the situation indicated in Figure 3. There are a collection of equations with regression coefficients multiplied by zero or 1 and if adding up these zero or ones produces the numbers shown at the bottom of the various columns.

For example, in column 2 of the figure, one gets T(I) x U as a total because if the U's are added over all of the population, T(I) people, one must get T(I) U's, or T(I) x U as a total. The only difference in the other columns is that there are both 0's and l's, so certain B's are multiplied by l's whereas the others are multiplied by 0's. Now some of the B's are multiplied by 1 because the people have that particular characteristic (e.g. they live in a city of over 100,000 population). So, when one adds up the l's in a column without considering the B's, one finds out how many of the T(I) people have the particular characteristic which is being considered. Obviously, for each socio-economic variable the number of people in each level of the variables adds up to the total number of people, T(I). So what is depicted in Figure 3 is the fact that individual equations for people can be added up and there is no need to consider equations for each individual but only to take the regression coefficients and multiply them by certain data, for example, from the census (e.g. data on how many females in Quebec come from cities of over 100,000 or come from certain household size categories, etc.). One can make estimates without knowing individual characteristics but by knowing the information indicated in Equation 2 following:

```
(2) N(i) = U(i)T(i) + ( @E B(i,1,j)n(i,1,j))
           + ( @E (B(i,2,j)n(i,2,j)) + ...
```

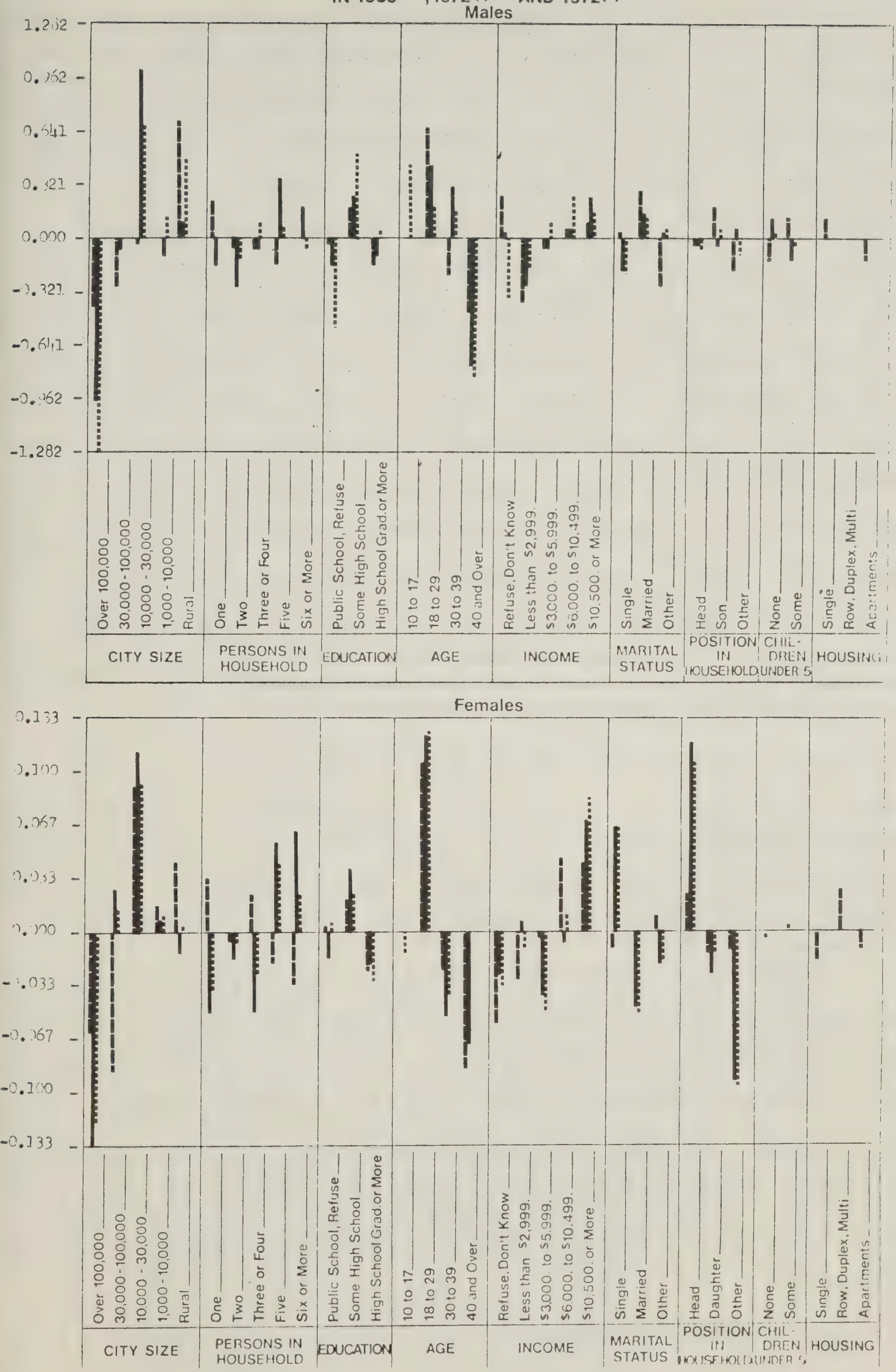
WHERE N(1) is the number of males participating in some activity and
N(2) is the number of females. The U(i) and B(i,.,.)'s are

FIGURE 2

BETA VALUES FOR

HUNTING FREQUENCY

IN 1969 – –, 1972 (1) — AND 1972 (2) ···



the parameters as defined earlier. They are male's parameters if i = 1 and female's parameters if i = 2.

Incidentally, the subscript for sex has been introduced to stress the importance of dealing with the two sexes separately for most activities. The importance of carrying out analyses where N(i)'s for the two sexes are predicted independently can be very easily understood. By looking at Figure 1 one sees that female participation in hunting has coefficients which look somewhat similar to the male coefficients but the male and female coefficients are not related so that one simply adds a constant value to the female effects to get the male effects. The female effects are scaled-down versions of the male effects and usually run from a quarter to a third as large. They tend to be in the same positive or negative direction. This multiplicative relation between coefficients is a true interaction effect such as described in many texts. Renoux (see Reference 11, 12) has presented a similar example in his analysis of the CORD Study data. Interactions are discussed from a different perspective in TN 20.

If one has an N(1) and an N(2) based on Equation 2, to get results for the total population one obviously need only add together male results and female results. However, Equation 2 was simply stated as giving an equation for predicting participation. This is because there are two approaches that may be taken to predicting frequency of participation. One is the approach which is implicit in the way that Equation 1 was defined and suggests that frequency be predicted as indicated in Equation 3:

(3) $TP(i) = U(i)T(i) + @E\ @E\ B(i,l,j)n(i,l,j)$

WHFRE the sums are on l and j and where TP(i) is total amount of participation in a given activity for males (i=1) or females (i=2). The other terms are as defined before, except they are the coefficients for a frequency model (see Figure 2 and Table 3) rather than the coefficients for a participation model.

Rather than using the equation for total participation just indicated, data can be used to obtain an average frequency of participation in hunting. For example, this may be computed by adding up the number of trips that each participant makes and dividing by a total number of participants. Actually, the average number figure should probably be disaggregated according to rural/ urban or in some other way that is consistent with the socio-economic variables considered in the analysis. This is so that as the population changes an appropriate change can be made in the amount of participation predicted. But, that was not done here. Equation 4 is not written in such a way as to allow for this:

(4) $TP = \hat{f}(1)N(1) + \hat{f}(2)N(2)$

Figure 3: Equations for Males Participating in Hunting for a Population T(i) Considering

"City Size" and "Number of People in the Household"

Probability of a person participat-ing in hunting				City Size							No. of persons in household									
		General Mean (1)		100,000+	(2)		.....	(3)			(4)		1-2	(5)		3-4	(6)		5+	(7)
Y(1,....)	=	U	+	B(1,1)	0	+	B(1,2)	0	+	B(1,3)	0	+	B(2,1)	0	+	B(2,2)	1	+	B(2,3)	0
Y(2,....)	=	U	+	B(1,1)	0	+	B(1,2)	1	+	B(1,3)	0	+	B(2,1)	0	+	B(2,2)	0	+	B(2,3)	1
....		...		....			....			....			....			....			....	
....		...		....			....			....			....			....			....	
Y(j,....)	=	U	+	B(1,1)	1	+	B(1,2)	0	+	B(1,3)	0	+	B(2,1)	0	+	B(2,2)	0	+	B(2,3)	0
....		...		....			....			....			....			....			....	
Total Estimated Participation																				

equals B(2,1) times the number of persons of sex i whose household size is 1 or 2. This is the no. of 1's in the column marked (3).

equals B(1,1) times the number of persons of sex i in the population who come from cities over 100,000. This is the number of 1's in the column marked (2).

equals U times the total population of sex i, UT(i), i=1 or 2. (indicated in column (1)). The figure is supposed to imply that there are T(i) U's in the column marked (1).

WHERE TP is total amount of participation in a given activity for males and females, the N(i) are as defined by Equation 2 and the $\hat{f}(i)$ are the average frequencies of participation for each sex. Really, the equation shows that one multiplies each of two types of participants by their average frequencies of participation. Renoux (see Reference 11, pages 66-67) has presented average frequency figures of $\hat{f}(1) = 4.4$ and $\hat{f}(2) = 3.0$ for hunting in Quebec.

Given the kind of equations just indicated, there is no need to use them with population figures for the year in which the data were collected on which the B(.)'s were determined. Obviously one can make predictions by using the equations. One can also see how the "prediction" equations introduced earlier are used by seeing that in each of Tables 5 and 6 the numbers of people in various socio-economic categories are multiplied by the effects associated with given socio-economic categories. These products have been added together in the ways specified by the equations, with the actual estimates being shown at the bottom of the tables as totals. The results of carrying out these computations are summarized in Table 7. In terms of computations, it is actually a very simple procedure to make projections using this kind of equation.

The real problem relates to determining the N( )'s, the numbers of people that are predicted to be in certain socio-economic groups at some time in the future. One should note that for the example in Tables 5 and 6 estimates were made of what the total Quebec population would be for males and for females in 1980. Estimates were also made of how many people would be in certain socio-economic categories. Care was then taken to see that the predictions as to the number of people in socio-economic categories agreed in total with the total number of people available to be in these categories:

(5) T(i) = @E h(i,k,j)

WHERE the sum is over all values of j and the condition must hold for all k, for all socio-economic variables considered.

It may seem odd that a point has been made of the fact that the number of people in various levels for socio-economic categories should add to the total number of people in a population. However, this has actually been found to be a problem for several reasons. For one thing, some researchers have projected the number of people in various socio-economic categories by drawing trend lines through the numbers of people in these categories at a number of census years. From this procedure they get estimated numbers of people in cities over 100,000 at future years. From another curve, estimated number of people in various other city size categories are obtained in a similar way. A trend line is drawn to determine the total number of people in the population being considered at some future points in time. There is no constraint that makes the prediction of "total

TABLE 5

THE PROJECTED HUNTERS IN QUEBEC IN 1980 CONSIDERING SEX, AGE, INCOME AND URBANIZATION IN THAT YEAR

	MALE			FEMALE		
	TOTAL POPULATION	GENERAL PARTICIPATION RATE	GENERAL MEAN	TOTAL POPULATION	GENERAL PARTICIPATION RATE	GENERAL MEAN
	2,150,782	0.274	589,314	2,274,707	0.033	77,502
VARIABLES	PERSONS	EFFECT	TOTAL EFFECTS	PERSONS	EFFECT	TOTAL EFFECTS
AGE						
18-19	94,626	-0.033	- 3,123	89,788	0.126	11,313
20-24	346,550	0.135	46,784	341,821	0.078	26,662
25-29	293,233	-0.045	- 13,195	269,524	0.055	14,824
30-34	189,092	0.181	34,226	255,290	-0.029	- 7,403
35-39	219,706	0.012	2,636	214,098	-0.038	- 8,136
40-44	198,264	-0.025	- 4,957	195,646	-0.037	- 7,239
45-49	168,657	-0.024	- 4,048	167,411	-0.054	- 9,040
50-64	414,605	-0.175	- 72,556	441,189	-0.048	-21,177
65-	226,049	-0.024	- 5,425	299,940	-0.053	-15,897
Sub Total			- 19,658			-16,093
INCOME						
0-2999	346,547	-0.143	- 49,556	366,514	-0.004	- 1,466
2000-4499	11,537	-0.067	- 773	12,202	-0.017	- 207
4500-5999	44,394	-0.022	- 977	46,952	-0.019	- 892
6000-7499	321,276	0.043	13,815	339,787	0.015	5,097
7500-8999	387,713	0.061	23,650	410,053	-0.006	- 2,460
9000-10499	331,777	0.138	45,785	350,894	0.015	5,263
10500-	707,538	-0.011	- 7,783	748,305	0.016	11,973
Sub Total			24,161			19,522
URBANIZATION						
1000-9999	244,701	-0.114	- 27,896	253,379	-0.021	- 5,321
10000-29999	191,021	0.162	30,945	198,139	0.016	- 3,170
30000-99999	198,309	-0.036	- 7,139	214,330	-0.017	- 3,644
100000-	1,198,204	-0.156	-186,920	1,309,365	-0.012	-15,712
Rural	318,547	0.072	22,935	299,494	0.034	10,183
Sub Total			-168,075			-17,664
TOTAL			425,742			63,267
TOTAL HUNTERS (TOTAL MALES & FEMALES PARTICIPATING)						489,009

TABLE 6

THE PROJECTED HUNTING FREQUENCY IN QUEBEC IN 1980 BY SEX, AGE, INCOME AND URBANIZATION

	MALE			FEMALE		
	TOTAL POPULATION	GENERAL AVERAGE PER CAPITA FREQUENCY	GENERAL MEAN	TOTAL POPULATION	GENERAL AVERAGE PER CAPITA FREQUENCY	GENERAL MEAN
	2150782	1.053	2264773	2274707	0.042	95537
VARIABLES	PERSONS	EFFECT	TOTAL EFFECTS	PERSONS	EFFECT	TOTAL EFFECTS
AGE						
18-19	94,626	0.039	3,690	89,788	0.353	31,695
20-24	346,550	0.742	257,140	341,821	0.315	107,674
25-29	293,233	-0.318	- 93,248	269,524	0.186	50,131
30-34	189,092	0.332	62,779	255,290	-0.121	- 30,890
35-39	219,706	0.280	61,518	214,098	-0.128	- 27,405
40-44	198,264	0.128	25,378	195,646	-0.137	- 26,804
45.49	168,657	0.036	6,072	167,411	-0.154	- 25,781
50-64	414,605	-0.850	- 352,414	441,189	-0.153	- 67,502
65+	226,049	-0.390	- 88,159	299,940	-0.161	- 48,290
Sub Total			- 117,244			- 37,172
INCOME						
0-2999	346,547	-0.671	- 232,533	366,514	-0.044	- 16,127
2000-4499	11,537	-0.232	- 2,677	12,202	-0.087	- 1,062
4500-5999	44,394	0.325	14,428	46,952	-0.091	- 4,273
6000-7499	321,276	0.231	74,215	339,787	0.070	23,785
7500-8999	387,713	0.077	29,854	410,053	0.071	29,114
9000-10499	331,777	0.366	121,430	350,894	0.025	8,772
10500+	707,538	-0.097	68,631	748,305	0.056	41,905
Sub Total			63,914			82,114
URBANIZATION						
1000-999	244,701	-0.320	- 78,304	253,379	0.002	507
10000-29999	191,021	-0.020	- 3,836	198,139	0.026	5,152
30000-99999	198,309	0.206	40,852	214,330	-0.066	- 14,146
100000+	1,198,204	-0.470	- 56,315	1,309,365	-0.061	- 79,871
Rural	318,547	0.320	101,935	299,494	0.099	29,650
Sub Total			- 502,509			- 58,708
TOTAL			1,581,106			81,771
TOTAL NUMBER OF TRIPS ESTIMATED (MALES PLUS FEMALES)						1,662,877

TABLE 7

THE RESULTS OF PROJECTING HUNTING PARTICIPATION AND FREQUENCY FOR 1980
USING EQUATIONS 2, 3 AND 4

	MALES	FEMALES	TOTAL	"SOURCES"
PARTICIPATION	425,742	63,267	489,009	EQUATION 2
TOTAL PARTICIPATION	1,581,106	81,771	1,662,877	EQUATION 3
TOTAL FREQUENCY	1,873,264 (1)	189,801 (2)	2,063,065	EQUATION 4

(1) This is the product of 425,742 and the average frequency for males given in the paper.

(2) This is 63,267 times the average frequency of participation of for females given in the paper.

number of people" obtained by adding together the numbers in (say) each city size or each level of education agree with the total number of people predicted to be in a population based on a trend line!

If the researcher uses "trend live" projection he must make some choice as to how to deal with the problem of differing totals. One simple approach is to make the kind of "trend line" projections for the number of people in various socio-economic categories. These projections can be used to determine what part (proportion) of a total population defined independently would be, say, in each level of education. The following equation then applies:

$$\text{Corrected Number in level 1 for variable X} = \frac{\text{(Estimated number in level 1 for variable X)}}{\text{(Sum of number in each level for variable X)}} * \text{"Correct Total"}$$

One other example of where problems have occured (where census information is not available on certain characteristics) is the following in which estimates were needed on income of household head. The problem arises in trying to procure information for each member of a household by income of head of household. This is obviously needed in the male and female models for which results were generated. Given that it cannot be obtained directly, an approximation approach was adopted in which the head of household income information for the total population was used, and accepting the fact that there will be some error if one simply says that males and females will have the same distribution of income of head of household. When the assumption noted is made, it is not sufficient to simply take the income of head of household distribution divide by two and call half the population males and half females. As was indicated above, it is necessary to use the distribution information for the total population to derive a distirbution such that the numbers in each level of the variables being considered do add up to the T(I) for that population. So, the distribution was expressed in percentage terms and T(I) was allocated according to such percentages.

DISCUSSION

Although it is a simple matter to make projections in the way that has been described, this does not mean that the procedure is correct. There are a number of different concerns which may be raised here. By using a particular model one may feel that it is implied that the structural adequacy of the model is accepted and the accuracy of the projections is not taken to be a point in question. However, the reader will realize that early in the paper it was indicated that only certain matters of concern about the model were to be pursued in this paper. One of those was

that the coefficients of the model were computed for nine socio-economic variables whereas in the actual analysis only three of these socio-economic variables were used. In statistical analysis, it is well known that the interrelationship between two variables - for example age and income - may be such that a coefficient which is used to take into account the effect of age may also reflect the effect of income. In the technical literature this is known as the multi-collinearity problem and an examination of the correlations between the variables that were left out of the model and the variables that were included shows that some of these variables are correlated. So, there is a possibility that there may have been an over or under compensation for some factors that reflect the behaviour of the people in the population. Renoux has commented on this problem and there are numerous discussions of the problem of multi-collinearity in the statistics and the econometrics literature.

Another type of problem is that the frequency models defined here seem to be poor models. Such a comment may seem odd. However, when Renoux (1973) began to seriously investigate how to predict the total amount of hunting in Quebec, he found that results obtained using the first form of the frequency model often did not make much sense. That is why the second type of frequency model was developed. It was concluded by Renoux and Beaman that problems with the "type 1 frequency model" were caused by the drastic skewness of the distribution of stated frequencies of participation. At first it was considered necessary to "correct" for this skewness by using weights so that the larger uncertainty that one may have in a person's statement that he participated 100 times rather than zero times would be reflected in estimates. However, soon the kind of problems with models discussed in a number of technical notes were recognized and it was decided that further work on a frequency model should be deferred until the research for these other notes was completed (for TN 6, 20, 29 and 35).

It may not be clear that there must be data on a specific age group before it is valid to make the predictions for this age group. What is the importance of this? The data from which the regression coefficients presented here were obtained were either for 10 years of age and over (1972) or for people of 18 years and over (1969). So for hunting it is quite possible to make predictions for, say, people 16 years of age and over by assuming that they have the same regression coefficients as people 18 years of age and over, if 1969 data are to be used. If 1972 data are used, coefficients must be defined in some special way using the age specific data which do not give month of birth. However, explicit age information need not be available. So it is possible to make predictions about total number of people of all ages participating in some activities.

To further illustrate this, if one knows on the average how many heads of households are with each picnicking party or has some other measure that can be used to divide or

multiply a predicted figure one can translate it into using parties. In other cases it is possible to use socio-economic characteristics to infer that if a respondent takes part in an activity, probably a certain number of other people do. The individuals weight can thus be increased to make estimates of all participation. In doing this care must be taken that children are not counted twice when weights for adults are increased to reflect that children will go with them on trips (e.g. each parent gets half the children). Still there is a large problem area of application for the technique that needs to be explored in terms of particular implications to make certain kinds of total use estimates that may be of interest to planners or managers.

In one case, an estimation problem may be overcome by considering that certain activities are carried out by family groups. Then family information and socio-economic information can be used to get regression equations. In other cases, average results from an adult analysis can be multiplied by inflation factors. But, as already implied what to do in particular cases involves research problems that remain to be solved in the future and must be solved in the context of each need for a special kind of information. They cannot be solved in any general way unless another kind of data base is created on people of all ages (or in some cases on families). In other words, no simple or universal answers can be given regarding what are the best data or what is the easiest way to arrive at acceptable estimates of total participation, number of people who participate in an activity etc.

On a very different matter it may have been noticed that this paper suggests the use of a cross-sectional equation for making predictions. TN 13 points out some of the concerns that arise because the coefficients of the kind of model proposed here are derived for a certain point in time and may be changing over time. Also there are comments made in this volume about the importance of recognizing that the relationship (previously referred to as collinearity) between, for example, age and some other variables actually reflects what may be treated as a causal relation. It is truly unfortunate that no CORD Study research has pursued the matter of developing causal models, for example the kind of path-analysis models that have been described by Blalock (see Reference 3). However, it is the case that in the CORD Study, socio-economic variables that do influence each other in a causal way and do not influence participation "independently" have been used. This approach, at best, is an approximation that creates difficulties in using the model for predicting the future.

Another point worthy of discussion is that the model introduced treats individuals as participating in one activity or another independently of their participation in other activities. But it has been indicated in TN 10, 32 and 37 (and as is well accepted among researchers) people's participation in one activity is related to their participation in other activities. Any model like the

present one which treats behaviour on an activity-by-activity basis may have structural problems related to the fact that activities are treated autonomously. Certainly when one considers making predictions of what will happen in the future, there is a danger that by using the model proposed here one is suggesting that what is important in determining peoples future behaviour is their socio-economic characteristics rather than their orientation to a variety of recreational activities. In fact, one important factor is definitely what happens in the development of the supply of facilities for different activities (on supply and participation see TN 29). In part, developments that take place with respect to supply affect participation, not in terms of peoples participation in individual activities but in terms of how in the future they allocate their finite time according to some kind of time budget. This depends on the supply of opportunities for a variety of activities that they find in the future as opposed to the supply with which they are confronted in the present.

The development of the Blackstrap Ski Development in Saskatchewan has had a drastic effect not only on the amount of skiing in Saskatchewan but on activities that were taking place in the time now filled by skiing and obviously not now taking place, or at least not as much. Both change in supply and substitution of one activity for another (as has happened with snowmobiling, biking and cross country skiing) have played important roles in altering the behaviour of a large number of Saskatchewan residents. The supply component of this change may quite possibly be taken into account to some extent on a single activity basis for some activities by incorporating a supply factor into the kind of analysis of variance model considered here (see TN 29). But as pointed out in CORD Study TN 10, the problem of how to compute the impact of the movement into skiing on other activities which were previously participated in by a person still remains as a matter for research. There are no practical answers at this point in time.

TYPE OF DATA NEEDED FOR MAKING PROJECTIONS USING THE ANALYSIS OF VARIANCE MODEL

In previous sections of this article it has been pointed out that census data were used to make certain projections. In practice there has been a continuing problem in getting good agreement between census definitions and the definitions used in the CORD Study National Surveys on which B( )'s are based. Also, published census results often do not give information such as education by age for males, or even income of head of household by sex of household member, which is necessary if the present model is to be used with income as a variable. Education by sex by age data are needed if the fact that education means something different for young people than old people is taken into account in a slightly more general model (see TN 20). The point is that

for a model such as the one introduced to be used there must be a great deal of care taken to see that survey definitions do correspond with census definitions. What is more, if special tabulations from census data are required, plans must be made well in advance of carrying out an analysis so that special tables can be produced and ready when projections are actually to be made.

The biggest complication in using the kind of model described, insofar as data are concerned, is that it is not the straightforward matter that one might suspect to make projections of what the age distribution of the population will be at some future time, or what the education distribution will be. If one gets into the matter of trying to predict the breakdown of education by age at some future time, the problems are truly very complicated. Now, it has been the case that statistical agencies responsible for making projections have refused to make the projection necessary to use the model described because they say they cannot make the required estimates accurately. But here one enters into a rather delicate problem of whether "accurate" projections are really needed for planning purposes. It is better to plan on the basis of the best projections that can be made rather than not plan at all.

It is not a straightforward matter to decide how good projections should be before a model should be used. But one can say that for using the model described here, there is no need to spend fantastic amounts of money on getting "extremely reliable" estimates of what the age distribution or education distribution is going to be in the future. The results predicted are not going to be accurate to the same degree as the predictions on the distribution of education or age, or none of the distributions will be accurate. As long as demographic variables are predicted with an accuracy somewhat greater than one feels is implicit in the analysis of variance model, little more is necessary. Certainly nothing is gained by having accuracy in population figures which is lost as soon as regression coefficients are applied to make predictions. (This and other matters are pursued in TN 6 and TN 20.)

CONCLUSION

This paper has presented a model for predicting participation in Outdoor Recreation. However, there has not been a wholehearted endorsement of using the procedure. Rather the paper should have provided the reader with a clear understanding of how the analysis of variance technique can be used should it appear better than other alternatives which might be used to generate the same kind of information. It might be chosen because other methods appear more costly or are not feasible for other reasons (e.g. data cannot be collected and analysed in the time available).

An important point to recognize is that the recognition

of how such a model can be used is an important research step towards developing more sophisticated models. There is certainly a need to develop such models so that extremely expensive surveys need not be carried but so that equally good results can be obtained by using predictive models along with census information.

Even now, for all the criticism that can be leveled against it, the model described here is good given that the present ability of researchers to make predictions is very limited. Massive amounts of money can be expended on surveys when the effort might better have been spent on trying to develop scenarios of what will happen in the future and thus to relate current behaviour to the way the population is likely to behave in the future. It is this point that is stressed in CORD Study TN 13. This latter note, to a certain degree, defends the use of the technique described here.

Appendix: Technical Note 12

The following appendix is a summary of the original version specifying (1) the Beta Values, (2) the estimated parameter value and (3) the standard deviation of estimated parameter for the given activities presented for both males and females.

APPENDIX *

* Numbers 1-91 indicate the numbers of the Figures in which Beta Values for the particular activity are plotted for Males and Females.

Table 1-91 for all the above Figures contain the actual estimated parameter values for the given activity for Males and Females.

For all the above Figures Table 1-A to 91-A are where the standard deviation of estimated Parameter Values for the given activity are presented for both Males and Females.

* 1. Beta Values for "Swimming Participation in City" - Males and Females.

2. Beta Values for "Nature Study or Bird Watching Participation in City" - Males and Females.

3. Beta Values for "Outdoor Photography Participation in City" - Males and Females.

4. Beta Values for "Visiting Historic Sites or Parks Participation in City" - Males and Females.

5. Beta Values for "Visiting other Parks Participation in City" - Males and Females.

6. Beta Values for "Driving for Pleasure Participation in City" - Males and Females.

7. Beta Values for "Sightseeing - Participation in City" - Males and Females.

8. Beta Values for "Snow Sledding or Toboganning - Participation in City - Males and Females.

9. Beta Values for " Picnicking Participation in City" - Males and Females.

10. Beta Values for "Walking or Hiking Participation in City" - Males and Females.

11. Beta Values for "Golfing - Participation in City" - Males and Females.

12. Beta Values for "Ice Skating Participation in City" - Males and Females.

13. Beta Values for "Bicycling Participation in City" - Males and Females.

74. Beta Value for "Outdoor Photography Frequency".

75. Beta Value for "Visiting Historic Sites or Parks Frequency".

76. Beta Value for "Visiting Other Parks Frequency".

77. Beta Value for "Driving for Pleasure Frequency".

78. Beta Value for "Sightseeing Frequency".

79. Beta Value for "Climbing Frequency".

80. Beta Value for "Snow-Skiing Frequency".

81. Beta Value for "Snowmobiling Frequency".

82. Beta Value for "Snow sledding or Toboganning Frequency".

83. Beta Value for "Picnicking Frequency".

84. Beta Value for "Walking or Hiking Frequency".

85. Beta Value for "Golfing Frequency".

86. Beta Value for "Ice-skating Frequency".

87. Beta Value for "Horseback Riding Frequency".

88. Beta Value for "Bicycling Frequency".

89. Beta Value for "Tennis Frequency".

90. Beta Value for "Fishing Frequency".

91. Beta Value for "Hunting or Fishing Frequency".

THE ACCURACY OF ESTIMATES OF PARTICIPATION AND FREQUENCY OF PARTICIPATION USING THE ANALYSIS OF VARIANCE MODELS

J. Beaman and M. Alvo

ABSTRACT

The purpose of this paper is to present the derivations of general expressions for the error to be expected when making predictions of frequency of participation and number of participants in recreational activities using linear regression and analysis of variance models.

The case of concern is when an analysis of variance model is developed on the basis of statements made by individuals about how frequently they participate in certain activities. Well known results on the variance of estimable functions are used to obtain estimates of the variance to be expected in making predictions of the total number of male participants in hunting and in fishing that can be expected in Quebec. The estimates made are for a given year taking into account the socio-economic characteristics that the provincial residents are estimated to have in 1980.

Details on the actual numerical computations are provided and illustrated so that the reader recognizes some of the operational problems that arise in estimating the accuracy of predictions. The difficulties are shown to be related to the way that computers obtain permeter estimates.

PURPOSE

The purpose of this note is to show how the accuracy of estimates made using an analysis of variance model can be assessed, when the model used can be accepted as being structurally sound.

INTRODUCTION

One of the models developed as part of the Canadian Outdoor Recreation Demand Study can be expressed as indicated in the formula below:

Probability of Participating in an outdoor recreation activity = General mean + Income effect + Age effect + Education effect + Family Composition effect + Urbanization effect.

In a mathematical form the equation is as follows:

(1) P = U + B(1,J) + B(2,K) + B(3,L) + B(4,M) + b(5,Q)

WHERE
P = the probability of an individual participating in a particular activity and
U = the constant for a particular activity (general mean)
B(1,J) ... B(5,Q) = the beta coefficients that apply to each category that defines the socio-economic status of the person being considered.

The value of the coefficients that were estimated for hunting are shown in Figure 1. On how to use the coefficients and how to read the Figure, should this be a problem, one may refer to TN 12.

The best known use of the analysis of variance technique, which resulted in the kind of model just described in relation to making predictions of participation in recreation activities, is the application of the technique by Mueller and Gurin (see Reference 9). More recently there have been a number of applications of the technique. In the Canadian Outdoor Recreation Demand Study it was originally recommended that the technique be applied by Hendry (see Reference 8). Subsequently TN 12 was prepared and as well two works have been prepared in Quebec by Renoux (see Reference 11 and 12).

What is important to this research report is recognizing that one of the equations for making predictions which is in TN 12 is what statisticians call an estimable function. In the jargon of statistics, any linear function of linear regression parameters where the coefficients of these parameters are numbers not considered subject to error, is an estimable function, so that the equation given below is an estimable function with known constants N, X(1), X(2), etc.

(2) E = VN + ∂E B(i)X(i)

The equation suggested for making estinates of the amount of participation in certain activity in a city as presented in TN 12 was as follows:

(3) E(T) = UN + ∂E B(1,j)n(1,j) + ∂E B(2,k)n(2,k)
+ ∂E B (3,l)n(3,l) + ∂E B(4,m) n(4,m)
+ ∂E B(5,q)n(5,q)

WHERE the sums are on j, k, l, m and q respectively;

E(T) = expected number of participants in a particular activity

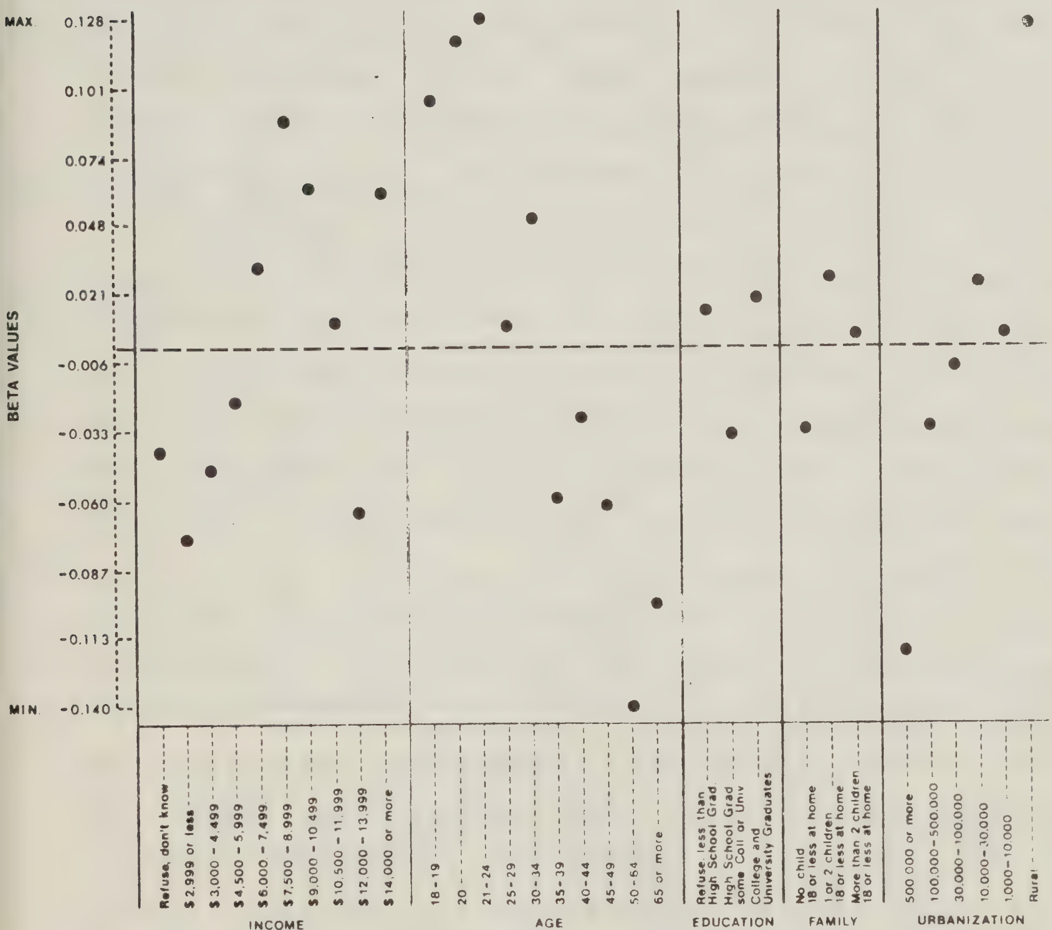
U = the general mean for a particular activity

N = the total population of a geographical area

FIGURE 1

RELATIONSHIP BETWEEN PARTICIPATION/NON-PARTICIPATION IN HUNTING AND SELECTED SOCIO-ECONOMIC CHARACTERISTICS

(FOR MALES)



B(1,j)...B(5,q): are the effects of being in a category (J...Q) of a socio-economic variable (1...5)

n(1,j)...n(5,q) = the number of people in the population who are in a cateogory (j...q) of a socio-economic variable (1...5)

In this paper a point is made of referring to E(T) rather than saying that T and the variance in T are estimated. This is because (1) for each individual one does not estimate a zero or one for participation or non-participation and (2) estimates are not made.

The expected probability of participating is for the same population for which parameters are derived so it seems most appropriate to say that the estimated are "expected participation for the population considered." Actual participation in a given geographic area in a given year could vary from an expected value for any number of reasons yet the expected value which was predicted using a model could be more appropriate for planning or policy than a predicted T that was really appropriate to a given place in a particular year (Expo 67 year or Olympic Games Year). Regardless, the main point is that E(T) is estimated for a city it has the variance which is estimated here. If however one is interested in the variance in T, the actual total participation, then each person does not contribute the variance in his predicted E(y), a variance that decreases with the size of survey on which the estimate is based. Each person contributes a variance which, if p is his estimated probability of participating, is p(1-p) and is a variance that does decrease as p is estimated based on larger and larger surveys. The matters just raised, if not clear to the reader, may be pursued by studying the ideas presented in TN 35.

By comparing the Equations 2 and 3 one can see that Equation 3 satisfied the definition for an estimable function and therefore the statistical theory that applied to estimable functions can be applied to find out what the accuracy in a prediction is which is made using this kind of a function to make an estimate.

Now, before proceeding to presenting details on the statistics involved, and still in the way of an introduction, it is important to note that the theory that is reviewed here is only appropriate if the model that is used is structurally appropriate to the data on which the model is based (to the situation that is being modelled). This matter has been taken up in CORD Study TN 20. Actually, the conclusion reached there is that the simple kind of model dealt with here is not usually structurally adequate. Fortunately, the theory presented here is quite appropriate to more complicated "generalized linear models" in which the interactions between the various socio-economic variables that must be considered to determine one's participation in an activity are taken into account so that the model defined is structurally adequate.

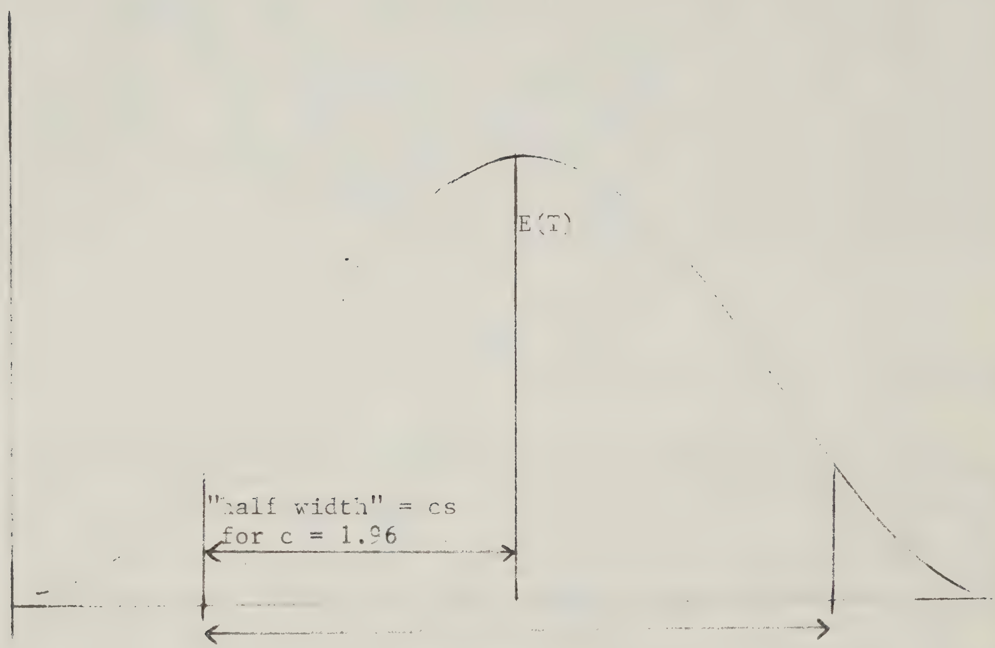
For the reader who is not fully aware of what makes a model linear, it is, from the point of view of the theory of concern here, that the model is linear in the parameters that are estimated. The coefficients of these parameters can be the squares of observations or almost anything one can imagine. One who is concerned about this matter may wish to pursue it further in such references as Netter and Wasserman (see Reference 10) or Scheffe (see Reference 13). Also, they may wish to note that there are innumerable ways of carrying out the kidn of analysis that is described here. One of these is referred to by economists as a dummy variable analysis. For example Goldberger (see Reference 7) indicates something about both what has been traditionally called an analysis of variance with normal nominal variables and dummy variable analysis, and indicates why these two forms of analysis are just algebraic equivalents when interpreted in the right way.

THEORY AND METHOD

Appropriate Measures of Error

The theory which is introduced subsequently gives a procedure by which one can estimate how much error may be expected in a prediction made using an estimable function type model. In fact what one finds from the theory is an estimated standard deviation, S, or estimated variance, S^2, for the estimate made. Sometimes by chance an estimate may be very close to the expected value that would be observed if one had perfect knowledge of a population. Other times, simply by chance, there may be a quite substantial error in a prediction. This means that once the computational procedure for estimating the amount of participation in an activity has been defined it is reasonable to question the accuracy of this estimate. Accordingly, let E(T) represent the expected amount of participation in an activity for a given population. A degree of confidence expressed as a percentage can be used to indicate how sure the researcher wants to be of his estimated value. Thus, to assess accuracy one must determine an interval as including estimates which are acceptably close to E(T).

The width of such an interval is a function of the degree of confidence chosen as well as of the variability of the estimate. Generally speaking, the higher the level of confidence, the larger the interval will be. Also the larger the variation in the estimate the larger the interval. As an illustration let the "width" as shown in Figure 2 of a symmetric interval around E(T) be defined as C times s (SCS) where c is a constant determined by the degree of confidence specified as well as by the sampling distribution of estimated values of E(T). This means that, if the estimate of E(T) has a normal distribution and if one wants to be 95% confident about the interval in which the E(T) lies one should let c=1.96. A convenient measure for



95% of area under curve: The range around E(T) in which an estimate has a 95% chance of falling.

FIGURE 2

A SIMPLIFIED WAY OF VISUALYING CONFIDENCE INTERVALS

IN RELATION TO T AND ITS ESTIMATED VALUE

accuracy is the value of CS; or if possible, the percentage of error defined by:

(4) % error = 100 * CS/estimate of E(T)

But caution must be exercised in using (4). If s is large compared to the estimate of E(T) the % error as defined above will be unreliable. Still the advantage in using equation (4) as a measure of error is that the measurement is made relative to an estimate of E(T).

The Variance in Estimates

It would be a simple matter to explain how to compute the variance in an estimable function if it were not for the fact that computers do not estimate parameters in models in the way that one might expect that they do. Some of the information generated by the computer while it carries out its computations is essential in estimating how much variance there is going to be in a prediction. Consequently, the following discussion deals specifically with the way in which a particular computer program computes the coefficients in the kind of equation introduced earlier. The method is actually very similar to that used in a number of standard computer programs so that the discussion should be sufficient to indicate in all the detail necessary what can be done to utilize information which can be extracted from most computer programs (if a systems analyst locates the appropriate point in the program and inserts a subroutine to dump the various arrays needed).

So, suppose that the amount of participation in hunting by the male population of Quebec is to be predicted for the year 1975. The data used are the 1972 Study National Survey Information on Canadians' participation in outdoor activities. (see Volume III) which contains information on respondent's participation in hunting and fishing and, as well, information on their income, the size of place in which they lived when they were interviewed and on their age when they were interviewed. Table 1 shows how the data on 1,271 males from throughout Canada were recoded for the purposes of the analysis reported here. The original data had more codes for the three variables income, urbanization and age. As well, information on fishing and hunting was the actual number of times that the person interviewed stated that they went hunting or fishing in the past year.

Table 1 actually presents much more information than an indication of the different levels of the socio-economic variables. It is set up in such a way as to facilitate the description of how a computer finally arrived at the estimates of the regression coefficients which are given in the table. When the computer had read the data, which one may think of as indicated by X's in the second column of the table, a number of statistics were computer and the data were transformed into the variables indicated by the X's for the purpuses of actually carrying out regressions.

TABLE 1

VARIABLES FOR AND RESULTS FROM AN ANALYSIS OF HUNTING AND PARTICIPATION FOR 1271 CANADIAN MALES

Variables and Levels	Variable Type and Symbol: Input	Transform (1)	Untransformed Variables: $\bar{X}$ or $\bar{Y}$	Standard Deviation	Means and Standard Deviations s.d.: Fishing Iteration 1 x or y	s.d.(5)	Fishing Iteration 2 x or y	s.d.(5)	Hunting Iteration 1 x or y	s.d.(5)	Hunting Iteration 2 x or y	s.d.(5)	Regression Coefficients: Fishing Iteration 1 B(.)	SDB	Fishing Iteration 2 B(.)	SDB	Hunting Iteration 1 B(.)	SDB	Hunting Iteration 2 B(.)	SDB
Income	(Nominal)																			
(1) 0-$5,999	X(1.1)	x(1.1)	.3753	.48439	.17467	26.32	.90883	112.92	.17467	26.32	.24856	57.65	-.03620	.01623	-.02659	.09144	-.07278	.02009	-.07647	.01960
(2) $6-10,499	X(1,2)	x(1,2)	.4240	.49440	.22345	27.02	.02339	82.30	.22345	27.02	.19624	56.13	.01347	.01497	.00739	.02271	.04738	.01853	.04966	.01890
(3) $10,500 -	X(1,e)	-x(1,1) -x(1,2)	.2006	.40063									.02274	.08127	.01919	.02756	.02540	.02261	.02681	.02284
Urbanization	(Nominal)																			
(1) 100,000 -	X(2,1)	x(2,1)	.4933	.50015	.13926	32.43	.93448	107.49	.13926	32.43	.14487	70.73	0.10259	.01518	-.08306	.02391	-.05659	.01879	-.05414	.01852
(2) 10-99,999	X(2,2)	x(2,2)	.1526	.35978	-.20142	24.34	-.01669	61.38	-.20142	24.34	-.21637	51.89	.05645	.01988	.04580	.03913	.06040	.02461	.05552	.02500
(3) rural - 9,999	X(2,e)	-x(2,1) -x(2,2)	.3540	.47841									.04614	.01611	.03725	.02969	-.00381	.01994	-.00137	.01977
Age	(Nominal)																			
(1) 18-24	X(3,1)	x(3,1)	.2140	.41029	-.16208	26.76	-93846	92.29	-.16208	26.76	-.27151	58.32	.09160	.01991	.09087	.03990	.08113	.02464	.08293	.02569
(2) 25-34	X(3,2)	x(3,2)	.1935	.39523	-.18253	26.10	-.93861	92.05	-.18253	26.10	-.29003	56.82	.04952	,02066	.03769	.04034	.06400	.02558	.06306	.02680
(3) 35-49	X(3,3)	x(3,3)	.2163	.41193	-.15972	26.84	-.93234	101.32	-.15972	26.84	-.26856	58.55	-.02935	.02002	-.03507	.03570	.00912	.02478	.00761	.02586
(4) 50 -	X(3,e)	$-\Sigma_j$ x(3,j)	.3760.	.48459									-.11178	.01737	.09348	.02580	-.15425	.02150	-.15361	.02101
Fishing Participation	(Interval) Y(.)	y(.)	.194	.395	.194	14.08	.0455.	65.8												
Hunting Participation	(Interval) Y(.)	y(.)	.391	.488					.391	17.39	.366	37.21								
Weight (4)	1	w(1)				.1271		99577		1271	5969									
Regression Constant $U - \bar{y} = \Sigma B(.)\bar{x}(.)$													.24172	.01299	.23584	.02600	.43949	.01608	.43795	.01661

(1) Transformed (1) by eliminating X(.,e) levels (see text) and (2) by the new variable being standardized to its mean (See the text).

(5) These are not really standard deviations because they have not been divided by the total weight for the regression. One may note that Fishing s.d. (Column 4) = .395 = 14.08 / (1271) 1/2= .395 (with 14.08 from column 7).

But before proceeding to comment on the means and standard deviations computed it is important to note that the headings, under "Variable Type" indicate that income, urbanization and age were treated as nominal variables. This means that though the variables were read in as having values such as 1, 2 and 3, they were transformed as indicated into variables which indicate whether a person had a given characteristic or not. Specifically for income if a person has income between 0 and $5999 then X(1,1) = 1 and otherwise it is 0. The third level of this variable is indicated as X(1,E) and has the indication after it -X(l,)-X(l,2) because this variable is not kept in the actual estimation of parameters but rather wherever a person is noted as having an income above 10,500 dollars per year (as of 1972). This is recorded by indicating that X(1,1) and X(1,2) have the value of -1. What this does is cause the information on all individuals to be stored in such a way that the regression coefficients estimated will be such that the sum of the first two income coefficients will be equal to minus the third coefficient. A simpler way of stating this is that for each variable income, urbanization and age, the way that data are defined results in the sum of the regression coefficients being equal to zero.

In actual computations this means that if a variable has three levels, only two regression coefficients are computed and the third is determined by adding the other two together and making the third coefficient equal to minus their total. Much is made of this here because it is very important in understanding what follows.

From the preceeding one can see that the capital X and x variables are different. This is why the results shown in the table indicate that the untransformed variables and the transformed variables have different means and standard deviations. However, the reader who is examining Table 1 may be confused by the fact that there are not just one set of transformed means. There are four sets of such means. The reason for this is a consequence of the actual computation of regression coefficients. The first computation of a coefficient was carried out assuming that each observation had the same importance and should have the same importance in determining coefficients so each observation was given a weight of one. However, when the second estimation step was carried the weights of observations were defined by the equation:

u(i) = ESY (l-ESY) if .01 < ESY < .99
and
100 otherwise

WHFRE ESY is the estimated probability of the individual participating estimated in the first iteration.

One may see the Smith and Cicchetti paper on using weighted regression which appears as an appendix to this volume. The reader may find it interesting to note in Table

1 that the means and standard deviation for fishing and hunting are exactly the same for the first iteration, the iteration with the observation weights equal to one. They will be the same for any activity. Only the means and variances for the dependent variables change for the obvious reason that a different dependent variable is being considered in the two cases. Also as indicated in a footnote in the table, the values listed for "standard deviations" for the transformed variables are not really standard deviations because they have not been divided by the appropriate weight to transform them into standard deviations. The reason for this is that all that is needed by the computer is the sum of crossproducts not variance estimates or standard deviations.

The computer actually solves for the B (.) in the following equation:

(6) y(.) = U+B (1,1) x (1,1) + B (1,2) x (1,2)
+B (2,1) x (2,1) + B (2,2) x (2,2)
+B (3,1) x (3,1) + B (3,2) x (3,2)
+B(3,3) x (3,3)

WHERE y (.) indicates an observation for a person with certain socio-economic characteristics. If the person being considered had income level 3, urbanization level 1 and age level 2, by note (1) on Table 1 one can see that:

(7) y(.) = U+B (1,1) (-1) + B (1,2) (-1)
+B (2,1) (1) + B (2,2) (0)
+B (3,1) (0) + B (3,2) (1) + B (3,3) (0)
= U+(-B(1,1))+(B(1,2))+B(2,1)+B(3,2)

In a matrix notation one may write the general equation above in the form (see Reference 13) as:

(8) y = U+ xB

For the initial computation of parameters called Iteration 1 in Table 1, the covariance matrix for the observations is considered to be a diagonal matrix with all diagonal elements being equal. On the second computation, Iteration 2, the variance in each observation is defined by the inverse of the weights w(i) introduced earlier. The covariance matrix of the y's, D, is considered to be a diagonal matrix with ones 1/w(i) on the diagonal depending on the iteration.

Now in matrix terms the least squares estimates of the B(.)'s are computed by:

(9) B = (x'DIx)**-1 x'DIy

WHERE B(.,e) = - @E B(.,i) and D is the convariance matrix of the observations with an inverse DI.

It is well known result (see Reference 13) of least squares estimation that the covariance matrix for the

parameters B(.) estimated is proportional to M which is the inverse of (x'DIx). The covariance matrix is s^2M where s^2 is the regression residual sum of squares divided by its degrees of freedom. But the computer does not compute M. (x'DIx) is converted to a correlation matrix by removing the standard deviation values given in the "Means and Standard Deviation" part of Table 1 for hunting and fishing. On the first iteration computation for both hunting and fishing for example, $(26.32)^2$, $(27.02)^2$ etc. appear on the diagonal of (x'DIx) but these are removed to get the correlation matrix C given at the top of Table 2. The following shows two relations of importance:

(Inverse of M) = SCS' = x'DIx

WHERE S is the row vector of "standard deviations" for the x's for the appropriate iteration, and

M = (1/s.d.) IC (1/s.d.)'

WHERE (1/s.d.) is the row vector with each element being the inverse of the same element in S and IC is the inverse of C.

For Iteration 1 for both fishing and hunting one may note that in terms of the last equation:

(12) (x'DIx) =

$$\begin{bmatrix} 1.26 & -.38 & .24 & -.04 & -.14 & .21 & .29 \\ -.38 & 1.13 & -.01 & -.02 & -.05 & -.13 & -.04 \\ .24 & -.01 & 1.67 & -1.00 & -.09 & -.07 & .12 \\ -.04 & -.02 & -1.00 & 1.61 & -.06 & .03 & -.02 \\ -.14 & -.05 & -.09 & -.06 & 1.96 & -.77 & -.75 \\ .21 & -.13 & -.07 & .03 & -.77 & 2.01 & -.72 \\ .29 & -.04 & .12 & -.02 & -.75 & -.72 & 1.99 \end{bmatrix} [1/s.d.]$$

and using the iteration 1 s.d. values from Table 1, one has:

(13) x'DIx =

$$\begin{bmatrix} .0018 & -.0005 & .003 & -.0001 & -.0002 & -.0003 & .0004 \\ -.0005 & .0015 & -.0 & -.0 & .0 & -.0002 & .0 \\ .0003 & -.0000 & .0016 & -.0013 & .0 & .0 & .0014 \\ -.0001 & -.0 & -.0013 & .0027 & -.0001 & .0 & .0 \\ -.0002 & -.0 & -.0001 & .0 & .0027 & -.0011 & -.0011 \\ .0003 & -.0002 & .0 & .0 & -.0011 & .0029 & -.0010 \\ .0004 & -.0 & .0014 & .0 & -.0011 & -.0010 & .0028 \end{bmatrix}$$

This is only shown to 4 decimals but six significant figures were used in actual computation.

But now, to finish with the matter of parameter

TABLE 2

THE FULL CORRELATION MATRIX
AND THE INVERSE OF THE CORRELATION
USED IN ESTIMATING THE REGRESSION COEFFICIENTS
GIVEN IN TABLE 1

Full Correlation in Matrix Giving Correlations Between All Independent and Dependent Variables

1-0: Full Correlation Matrix Used in First Iteration Computations

1.0				FISHING 0
0.37058	1.0			HUNTING 0
-0.05115	-0.11747	1.0		INCOME 1
0.03686	0.06794	0.28862	1.0	INCOME 2
-0.13626	-0.00746	-0.19660	-0.02572	URBAN 1
-0.01882	0.05220	-0.09563	0.00943	URBAN 2
0.19061	0.21162	0.12346	0.10232	AGE 1
0.16562	0.21074	-0.23054	0.09472	AGE 2
0.11979	0.18283	-0.26111	0.05287	AGE 3
FISHING 0	HUNTING 0	INCOME 1	INCOME 2	

1.0					URBAN 1
0.61507	1.0				URBAN 2
0.11825	0.10514	1.0			AGE 1
0.11135	0.07753	0.63012	1.0		AGE 2
0.06117	0.05680	0.61940	0.62916	1.0	AGE 3
URBAN 1	URBAN 2	AGE 1	AGE 2	AGE 3	

1-1: First Iteration C**-1 Matrix for Hunting and Fishing

1.25901				INCOME 1
-0.37745	1.12887			INCOME 2
0.23854	-0.00673	1.67108		URBAN 1
-0.04053	-0.02474	-0.99660	1.61452	URBAN 2
-0.14297	-0.04776	-0.09181	-0.05987	AGE 1
0.20741	-0.13470	-0.06921	0.03039	AGE 2
0.29447	-0.04209	0.11743	-0.02205	AGE 3
INCOME 1	INCOME 2	URBAN 1	URBAN 2	

1.95767			AGE 1
-0.77463	2.00615		AGE 2
-0.75101	-0.71860	1.99048	AGE 3
AGE	AGE	AGE	

1 2 3

1-2: Second Iteration C**-1 Matrix for Fishing

	INCOME 1	INCOME 2	URBAN 1	URBAN 2
INCOME 1	1.48289			
INCOME 2	-0.19112	1.07480		
URBAN 1	-0.16122	0.12685	2.03237	
URBAN 2	0.05679	-0.04735	-1.24041	1.77588
AGE 1	0.00896	-0.12623	0.24138	-0.17243
AGE 2	0.35306	-0.15277	0.08812	-0.01102
AGE 3	0.47955	-0.01466	0.16574	-0.01409

	AGE 1	AGE 2	AGE 3
AGE 1	4.17277		
AGE 2	-2.01214	4.24506	
AGE 3	-1.69177	-1.59875	4.02737

2-2: Second Iteration C**-1 Matrix for Hunting

	INCOME 1	INCOME 2	URBAN 1	URBAN 2
INCOME 1	1.27098			
INCOME 2	-0.35399	1.12045		
URBAN 1	0.20855	0.01114	1.70824	
URBAN 2	-0.01738	-0.03822	-1.05457	1.67592
AGE 1	-0.10803	-0.07368	-0.05452	-0.08860
AGE 2	0.24050	-0.15088	-0.04705	0.01560
AGE 3	0.31928	-0.04290	0.12654	-0.02587

	ACE 1	AGE 2	AGE 3
AGE 1	2.23492		
AGE 2	-0.92815	2.30860	
AGE 3	-0.88856	-0.86127	2.28141

<><><><><>

estimation, the parameters obtained from the different computations using Equation (9) are presented in the right hand part of Table 1 and could be plotted, as were the more detailed analysis results shown in Figure l. One will also note that the estimated standard deviations in the B (.)'s are given so that one may have a feel for how accurate the individual coefficients are. Finally the "standard" statistics for the various regression carried out are presented in Table 3, where one sees that the percentage of variance explained was not very high. Still all of the results were highly significant as indicated by the F-test

results given: F greater than 2.66 has a probability of less than .01 of occurring by chance.

However it is not part of the purpose of the authors to use this paper as a vehicle to discuss the regression results, though some points are raised in the "Discussion" section of the paper. The important result in terms of this paper is that in making an estimate of the number of Quebec males participating in hunting and fishing, a computation must be made using the B (.)'s in Table 1 and the population distribution figures given in Table 4. The equation used to make the estimates given in the next to the bottom line of Table 4 was obviously:

(14) E = NU + @E n(i,j) B(i,j)

WHERE the sum is over all appropriate i and j.

But, this equation contains B(i,j)'s for which there are not covariance elements in M. Furthermore the elements in M are for observations about their mean. But consider the following which is derived based on the well-known relation shown in the last line of Table 1:

(15) E = N($\hat{y}$ - @E B(i,j) $\hat{X}$(i,j)) + @E n(i,j)B(i,j)

(16) E = N($\hat{y}$ + @E B(i,j) (n(i,j)) - N$\hat{X}$(i,j))

WHERE if weighted regression results are used $\hat{y}$ and $\hat{x}$(i,j)'s must be the appropriate weighted means.

Now the measurements are about the means, but the fact that B(i,e)= @E B(i,j) over j not equal to e, must be introduced to remove the B(i,e)'s from the equation. This results in:

(17) E = N$\hat{y}$ + @E B(i,j)(n(i,j) - n(i,e)) -
N($\hat{x}$(i,j) - $\hat{x}$(i,e)))

In matrix notation one can write:

(18) E = N$\hat{y}$ + mB

WHERE m is the vector with elements n(i,j) - n(i,e) - N($\hat{x}$(i,j) - $\hat{x}$(i,e)) and

B=(B(1,1),B(1,2),B(2,1), ... etc.)

Regardless, whether one uses the matrix equation just specified or the other form of the equation one has an estimable function as defined earlier in the paper. What is more, since one also has an estimated covariance matrix for the B (.)'s, one could use the formula for estimating the variance in E except that there is variance in a prediction due to variance in the y mean, and the parameter covariance matrix only interrelates the B (.)'s. But this is because

TABLE 3: STATISTICS ON THE REGRESSIONS FOR WHICH COEFFICIENTS ARE GIVEN IN TABLE I

	FISHING		HUNTING	
	Iteration 1	Iteration 2	Iteration 1	Interation 2
Total Sum of Squares	198.387	4326.578	302.658	1385.144
Explained Sum of Squares	15.169	222.517	21.904	116.165
R	.076	.051	.072	.084
Residual Sum of Squares (Rss)	183.218	4104.059	280.754	1268.979
Residual Sum of Squares Degrees of Freedom	1263.000	1263.000	1263.000	1263.000
Regression Degrees of Freedom	7.000	7.000	7.000	7.000
F-Statistic	14.938	9.783	14.077	16.517
Standard Error of Residuals	.381	1.803	.471	1.002

* All the F values are highly significant since the .01 level is 2.66.

TABLE 4: INFORMATION OF RELEVANCE IN ESTIMATING NUMBERS OF MALE PARTICIPANTS IN HUNTING AND FISHING IN QUEBEC in 1975*

Variables and Levels	N and n( )'s Numbers of People in the Given Class		FISHING		HUNTING	
	Symbol	Number in 1000's	Iteration 1 B( )'s	#Times** B( )'s	Iteration 2 B( )'s	#Times** B( )'s
Total Population	N	1980	.24172	478.61	.43795	867.14
Income (1)	n(1,1)	685	-.03620	- 24.8	-.07647	52.38
(2)	n(1,2)	810	.01347	10.91	.04966	40.22
(3)	n(1,e)	485	.02274	11.03	.02681	13.00
Urbanization (1)	n(2,1)	1093	-.10259	-112.00	-.15414	-59.18
(2)	n(2,2)	333	.05645	18.8	.05552	18.49
(3)	n(2,e)	554	.04614	25.56	-.00137	- .76
Age (1)	n(3,1)	398	.09160	36.46	.08293	33.01
(2)	n(3,2)	448	.04952	22.18	.06306	28.25
(3)	n(3,3)	553	-.02935	-16.23	.00761	4.21
(4)	n(3,e)	581	-.11178	-64.98	-.15361	-89.25
Total to give Estimates correct for Socio-Economic Composition of the Quebec Population				385.58		802.75
Estimates Based on Unweighted Means*				384.72		774.18

* Estimates are based on unweighted means because the hypothesis that is implicit in making the computation is that all people have a probability of .194 of fishing and .391 thus the same variance should be associated with every observation which is what occurs when an unweighted mean is computed.

** These columns contain the products of n(i,j)'s times the B( )'s.

the B(.) were computed in a space from which the variance related to $\hat{y}$ has been extracted so the appropriate covariance matrix to use with the estimable function is:

$$s^2V = \left[\begin{array}{c|c} \text{@E } w(i) & 0 \\ \hline 0 & s^2M' \end{array}\right]$$

WHERE, as before, s(2 is an estimate of error variance.

Then by the standard formula for the variance in an estimable function (see Reference 13).

(20) For iteration 1, W(i) = 1271 (See Table 1 column 6 or 10) and the n's from Table 4)
Var (E) = (s^2N^2/ @E W(i) + s^2 mMm'

Using the $\hat{x}(.)$'s from column 4 of Table 1 and the n's from Table 4, one notes that with population figures in thousands, for hunting or fishing first iteration:

N = (-146,-117,263,178,138,228,288)

WHERE N is the vector of n(i,j)'s

Now, the above N is appropriate for both first iteration hunting and first iteration fishing because the means used in computing it do not depend on the dependent variable. For example the first element in "m" has to do with the first level of the first variable, M(1,1). From Table 4 n(1,) = 685 while n(1,e) = 485. The related means from column 4 of Table 1 are .3753 and .2006 so that:

m(1,) = 685 - 485 - 1980 (.3753 - .2006)
= -146

Actually the difference in the means, .3753-.2006 = .1747 can be read from Table 1 in the columns 6 or 10. This is important because to obtain the vector "m" for a weighted analysis, Iteration 2, one should not use the means from column 4 of Table 1 because these are unweighted. Relevant weighted means only occur in columns 8 and 12 so one has:

weighted y means for hunting (col. 12) = .366
weighted y mean for fishing (col. 8) = .0455
weighted x(1,1) mean minus x(1,e) mean for hunting (col 12) = .24856
weighted x(1,1) mean minus x(1,e) mean for fishing (col 8) = .90883

The values just cited and not the columns 4, 6 and 10 values must be used in computing "n" for a second iteration.

So, for the second iteration hunting with numbers in

1000's one has:

$$
m' = \begin{array}{l}
685 - 485 - 1980\ (\ .249) = -292 \\
810 - 405 - 1980\ (\ .196) = \ -64 \\
1093 - 554 - 1980\ (\ .145) = \ 252 \\
333 - 554 - 1980\ (-.216) = \ 207 \\
398 - 581 - 1980\ (-.272) = \ 351 \\
448 - 581 - 1980\ (-.290) = \ 441 \\
553 - 581 - 1980\ (-.269) = \ 504
\end{array}
$$

For fishing or hunting first iteration working with populations in 1000's, one has:

(21) $VAR(E) = (.381^2)\ ((1980)^2/1291) + (218.32))$
S.D in E = standard deviation in E = 21.89

WHERE the .381 is the value of s obtained from the standard error row of Table 3 and the 218.32 comes from N'VN using the V defined in Equation 13.

The V-matrix for second iteration hunting was computer using the "standard deviations" given in column 13 of Table 1 and the last matrix in Table 2 so that for second iteration hunting:

(22) $VAR(E) = (1.002)^2\ ((1980)^2/5956 + 99.02)$
S.D in E = standard deviation in E = 27.55.

Now, applying the accuracy formula given in Equation 4 with c = 1.96:

% error in hunting at .05 level = (1.96) (27.55) (100)/ 774 = 6.60% where 774 is obtained from Table 4;

% error in fishing at .04 level = (1.96) (21.89) (100)/386 = 11.13% where 386 is obtained from Table 4.

Actually since one can get the first iteration VAR(E) for hunting by replacing (.381) by the similar regression s for hunting of (.471) (see Table 3) one may note that based on the first iteration VAR(E) for hunting = $(.471)^2(21.89)^2(.381)^2$ or in standard deviation terms for hunting first iteration the standard deviation in E = 27.06. The estimate would have been just as accurate if the second iteration had not been carried out. This point is pursued subsequently (in the discussion).

Noting that first iteration estimates MAY BE AS ACCURATE AS second iteration estimates one may wonder how accurate estimates would be if it was assumed that socio-economic factors need not be considered and thus the participation figures shown in the last line of table 4 were simply computed by E(T) = means of the dependent variable times N, the total number of people being considered.

Now if one is interested in the accuracy of these estimates then one is assuming that all people have the same

probability $\hat{y}$ of participating. One can ignore the M matrix, and by the above, compute:

$$E = N\hat{y}$$

$$\begin{aligned} VAR[E] &= [N]\,(S^2/1271)\,[N]' \\ &= (T^2\ S^2/1271) \\ &= (T^2/1271)\,(TSS/1270) \end{aligned}$$

WHERE S^2 is now TSS, total sum of squares, divided by 1270 because only 1 degree of freedom is involved in computing the mean of the dependent variable. Actually because Y has a binomial distribution one may just as well use:

$$VAR(E) = N^2 - \hat{y}\,(1-\hat{y})/1271$$

This is based on the variance in the mean of the sample of size N from a (0-1) variable being estimated by $\hat{p}(1-\hat{p})$ and on the fact that K times a random variable with variance x having a variance K^2x.

Using either formula one obtains:

standard deviation hunting = Var (E for hunting)**(1/2) = (1980) (.391(1-.391)/1271)**(1/2) = 27.11

standard deviation fishing = Var (E for fishing)**(1/2) = (1980) (.194(1-.194)/1281)**(1/2) = 21.97

The standard deviations for the estimates made using the mean do not differ from those obtained when socio-economic effects are considered except in the third significant figure. One can reasonably ask: Why consider socio-economic should be considered if accuracy of estimates is not increased?

DISCUSSION

Given the results presented in the last section the first question which seems appropriate for discussion is the one just raised: "Why consider socio-economic effects?" As indicated by the results presented, the predictions made using the general mean are as accurate or more accurate than projections made considering socio-economic effects. Why bother with socio-economic effects? Using the general mean to make estimates is based on the assumption that socio-economic effects remain constant and on the assumption that the population for which an estimate is made is the same as the population for which the general mean was obtained. If in fact the desire to make an estimate for a population based on a biased sample, on a sample that for some reason is distributed differently than the population for which estimates are being made, it is necessary to take into account the differences in distribution as reflected by the

kinds of effects computed and considered using the model presented here. If this is not done the estimates made using the general mean may appear to be very reliable but they may not be valid in the sense that they are biased. The bias can be very substantial compared to the error that may be related to making an estimate. Obviously, if the general mean is used to make an estimate for a population that is much more aged than the population on which the general mean is based, then participation in most activities would be over predicted. The important factor in this error is the bias due to failure to consider age, rather than any inaccuracy in the general mean which was used.

For the data used the bias involved in using the mean to make predictions is so small that one can accept that differences are "strictly statistical". As one can see from Table 4 the differences in predictions made using the mean and ones considering socio-economic factors are under 1.56 times the appropriate standard deviation in E(T).

Actually, the socio-economic characteristics would play a more important role if they contributed more to the R^2 for the model. However, the fact is that they do not contribute much and this is simply a reflection of the fact that Socio-Economic characteristics are not a terribly strong determinant of peoples participation in activities. They are still a determinant which can be taken into account to improve predictions. Using these guards against differences in a sample and the group for which estimates are made resulting in a bias.

Turning to another point, the fact that sample size gives a good estimate of the variance of estimates in which socio-economic effects have been considered means that sample sizes needed for certain accuracy can be computed. Consider for example that:

	max % error acceptable (AE)	
AE =	at a given	= (100 C (N^2 $\hat{y}(1-\hat{y})$ *
	level of	sample size)**1/2)/ E(T)
	confidence X	

WHERE all variables are as defined earlier.

From the equation above, given that E(T) will be close to pN in value:

$$\text{Sample size} = 100^2C^2N^2\hat{y}(1-\hat{y})/(AE)^2P^2N^2)$$
$$= 100^2C^2(1-\hat{y})/(AE)^2P$$

So, if one desires AE=±5% accuracy at the .05 level (c=1.96), one is not concerned with the size of population, N, for which estimates are to be made but must also accept that the accuracy is only needed for greater than some value, say, .10. Then one has:

Sample size = $100^2(1.96)^2(1- .1)((5^2)(.1))$
$= 3600 * 1.96^2$
$= 13,829.76$

The reader may recognize the formula just introduced as the well known one used in selecting sample sizes in surveys but should recall that its relevance here arises because of the fact that correcting estimates for the socio-economic characteristics of populations considered does not result in estimates which are much more "accurate" if socio-economic effects need not be use to correct for bias. Certainly if the population for which estimates are made differs drastically from the population on which an estimation model is based the accuracy of estimates may not be as good as implied by the formula even though the correct sample size population was used in estimating regression coefficients. In line with the points made earlier one can see that sample size has been computed on the assumption that considering S-E effects does not effect the variance that would occur. However, if models with higher R^2 can be developed, then a less conservative estimate of necessary sample size could be used (for other sample size considerations see the appendix to TN 29).

Moving to a rather more technical matter, one may have thought it was a matter of not over illustrating a point which resulted in the choice to present material on iteration 1 for fishing and on iteration 2 for hunting. Actually, the choice was a very conscious choice based on the fact that one can say in an unambiguous way that the model arrived at through iteration 2 on fishing is an invalid model. In the end of the review material for Chapter VII of this volume there is a brief introduction to the matter of how to determine whether one can accept the kind of analysis of variance model used here as structurally valid. The point made there is that when the iteration 2 run is made, and one supposedly corrects for the variance in the observations, then the predictions of each observation should be distributed in a well designed way. When one computes an average value of the residual they should expect this average value of the residual to come out to be close to 1. Now if one looks at Table 3 they see that the average value of the residual for iteration 2 fishing, there called standard error of the residual, is 1.8. One can compare this value of 1.8 with the value of 1.002 for the second iteration of the hunting model. As described in the review of Chapter VII the residual sum of squares values should be distributed as chi-squared so the approximation shown in the first equation can be used to get the significance test shown in the two equations which follow it:

$(2X^2)**1/2 - (2(NO-NP)-1)**1/2$ approx = normal (0-1)

WHERE NO = number of observed and
NP = the number predicted.

((4104)2)**1/2 - (2(1263)-1)**1/2 approx = 40

which is much greater than the 1.96 deviations that have less than .01 probability of occurring. On the other hand one has:

((1269)2)**1/2 - (2(1263)-1)**1/2 < .2

and one can accept the hunting "model" as valid because a deviation greater than .2 must be accepted as one of the many values having a high probability of occurring by chance.

One should recognize that accepting the hunting model is not a strong test. There is a distinct possibility of a type 2 error' that is accepting the hunting model when there are still structural problems with it. Two points are important in this regard. Firstly, results presented in TN 29 show that the hunting model is probably not valid because the effect of supply on participation is not considered in the model. Yet it is noted in TN29 that the effect of supply on participation in hunting (in fact for all 19 activities for which information was available in the data used in this study) could not be demonstrated with data on 4,000 people. There it is shown that (1) supply distribution is important in explaining participation in hunting and fishing and (2) all that was needed to demonstrate this was a larger data set. In this other technical note the great importance of considering supply factors if large biases in estimates is to be avoided is illustrated. Secondly, a point has been made here of the value of using weighted regression. Work carried on in revising this note was critical in clarifying that there was less reason to use weighted regression than had been thought. This matter is pursued in an addition to the review of Chapter VII that describes why the chi-squared tests of model structural adequacy presented earlier can be made without having the results of a weighted regression.

Finally, from a planning, management and research planning perspective the results presented here must be considered very important. It is not hard to find planning reports or documents prepared for management where projection techniques less sophisticated than the one described here are applied with no mention of the fact that there may be some error in the results which are produced. There is often great inefficiency in carrying out research because the proper questions are not asked about how accurate results needs to be and thereby the question does not arise as to whether projections could be made by a method like the one described here rather than going through the laborious, expensive and time consuming job of primary data collection. How many times is it that data are collected but are not applied in a certain situation because the universe for a study was not quite right, because the data are a couple of years out of date etc. So, a new survey is carried out, but still there is no adequate

consideration of what accuracy is going to be gained by having the new survey or even if the new survey will give results which are as accurate as are needed by planners or managers. Often budget dictates sample size.

Very often researchers work under the misimpression that planners and managers need results which are far more accurate than what they actually need. Accurate figures are needed on how many people actually do use facilities so that use trends etc. may be plotted to justify program expenditures, but in terms of planning for traffic, setting up adequate facilities to begin operation of a park, etc., there is no need to be accurate within plus or minus 10%. Even in many cases much lower levels of accuracy are quite adequate. Most road designs have a leeway of about 50%.

In part the points made above relate to using the kind of model presented in designing good research. A part of designing good research is not carrying out research when it will not produce results. And not going through extra labor when rather simple computations will give adequate results for planning or management decision making. In this regard it is important to note that the kind of results presented here are important in making a decision as to whether estimates should be made or a survey should be carried out. What level of accuracy can be achieved given the funds that are available must be considered. Obviously, a $5,000 data collection effort is not a good expenditure for making a decision about carrying out a $5,000 project. To reiterate a point, if a researcher could elicit a good feel for necessary accuracy for management and planning, he would usually find out that a very small scale study of the likely use of a facility to be built, is quite sufficient to provide information on which decisions should be taken. Furthermore whether millions or thousands of dollars are involved the question which must ultimately be asked is whether a survey which goes beyond a certain scale is producing anymore worthwhile information than a smaller study.

Of particular importance in relation to the last point is that the prediction of more accurate results by bigger and better surveys doesn,t occur beyond a point. Till now, in this paper, accuracy has been discussed as if the X(.)'s, N, n(.)'s etc. were known and constant. But one of the greatest problems faced in making projections is that one cannot even project total population accurately much less project the number of people who will have certain levels of income or be in cities or households of a given size (see TN 12). There is no point in paying a high price to have a model which gives ±1% results under assumptions about what the total population will be in 10 years when the prediction of this has a high probability of being in error by ±10%. At most the aim should then be to have a model that gives estimates to around ±5%. That is, unless data for the "more accurate" model must be collected to meet some other need.

CONCLUSION

The results presented in this article show it is not a terribly difficult matter to obtain estimates of the accuracy of predictions that can be made using the kind of analysis variance equations that have been used in recreation research in the past. It has been pointed out that the reason for getting involved in the use of such equations is that at least in theory results from National Surveys can be used to make predictions for particular geographical areas. This means that the mammoth survey cost of doing detailed surveys in small areas might be avoided.

However, a word of caution has been added in this regard. This was because of the known difficulties in developing structurally adequate models.

From another perspective the importance of being able to make accuracy estimates relates to the researcher being able to indicate to the planner or manager for whom he is doing research the importance of knowing the general level of accuracy needed for certain purposes. Often when data are "needed" there is no choice of carrying out a survey (or of gathering any primary data) to determine what the participation level of population is because there is no time. Estimates must be made. There is however a choice of how sophisticated one should get in terms of computations that are carried out to arrive at estimates. It is going to be a matter of experience to know when interaction effects can be ignored and when supply factors such as those discussed in TN 29 can be ignored, and a model such as that used used here still be employed and be relatively accurate. But still, using an analysis of variance model one cannot expect to exceed the accuracy in E estimated by the methods given here. If this accuracy is not acceptable for planning and/or management purposes then the nature of the problem faced can be stated clearly: it must be accepted that the decision will have to be made with little or no information in which one can put faith if there is no time to collect data.

Finally, possibly the most important consequence of the research presented here is the rather clear conclusion that can be reached that the level of accuracy that can be obtained in predictions is largely determined by the percentage of the populations that participates in an activity so that a good guideline has been provided for survey design. If researchers can speak to planners and managers and find out what accuracy they really need in information about participation and activities, they have a good guide to use in deciding what sample size is needed in surveys. They know that predictions will only get worse when the results attained in the survey are applied to populations which differ drastically from the population on which data were collected.

ANALYSIS OF VARIANCE MODELS WITH INTERACTION EFFECTS AND THEIR POTENTIAL ROLE IN UNDERSTANDING AND PREDICTING RECREATION BEHAVIOUR

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ABSTRACT

This paper focuses on certain issues that are important in understanding the value of analysis of variance models in recreational research, particularly whether a simple analysis of variance model is structurally sound and whether its use may lead to errors in estimating behaviour.

The results of the Michigan Automatic Interaction Detector (AID) program and of regression analyses of the 1969 and 1972 Canadian Outdoor Recreation Demand Study National Survey Data on Canadian's Participation in Outdoor Activities are included to illustrate how interaction effects affect analysis when trying to explain participation in an activity using socio-economic variables as the independent variables. The results of the analysis of simulated data are presented to show the degree to which AID explains data as compared to using a correct analysis of variance model. Conclusions are that:

(1) significant interaction effects exist when one tries to explain Canadian residents' participation in outdoor activities in terms of their socio-economic characteristics;

(2) a simple main effect analysis of variance model is not adequate to explain most recreational behaviour;

(3) the use of the AID analysis program gives one an idea of the magnitude of the sum of squares associated with interaction effects but its use does not provide a systematic way of identifying these effects; and

(4) repeated application of traditional regression methods to identify interactions does result in "finding" interaction terms that improve a simple linear model but the improvement achieved by introducing ten interaction terms is usually only the explanation of 1/5 of the interaction sum of squares that should be explained; what is more, the possibility of type II errors in selecting interaction effects raises serious questions about the use of this approach to improve (define appropriate) models.

INTRODUCTION AND PURPOSE

The best known use of analysis of variance modelling techniques for predicting participation in recreation is attributable to Mueller and Gurin (see Reference 9). More recently other examples of applying this technique have become frequent. In the Canadian Outdoor Recreation Demand (CORD) Study, Hendry (see Reference 8) suggested using analysis of variance (in the form of dummy variable analysis); this technique was actually pursued using a 1969 National Survey to develop differentials related to age, sex, family status, etc. Subsequently, TN 12 of the Canadian Outdoor Recreation Demand Study showed how the socio-economic differentials for 26 activities could be used in making projections. Renoux (Reference 11, 12) used this methodology to develop a hunting model and other models for the Province of Quebec.

An important result of previous CORD Study work and Renoux's research has been the identification of a number of problems associated with the use of analysis of variance techniques. The purpose of this paper is to focus on one of these problems in particular. The stucture of the note reflects somewhat the history of the research on the problem that interaction effects pose in developing analysis of variance or other regression models. It is convenient to present some definitions and then describe some early research from which no results are presented. This research led naturally into other "successful" steps in analyzing data to find the existence of interaction effects and finally led to the few positive results that are presented in this paper. Through this strategy of showing the background of research the authors believe that the reader will get the best "feel" possible for the multitude of problems involved in developing and improving the kind of models of concern here.

The data used in the various analyses presented are not described in any detail but are documented in Volume III.

DEFINITIONS

The term "a simple analysis of variance model" is used here to refer to a model in which participation or non-participation in an activity can be expressed as the cumulative sum of socio-economic effects. It is the kind of model defined and described in detail in TN 12 (see also TN 15). In equation form such as a model is:

$$(1)\ Y(i,J,K,L,M,Q) = U + B(1,J) + B(2,K) + B(3,L) + B(4,M) + B(5,Q) + C(i)$$

WHERE Y(i,J,K,L,M,Q) is 0 or 1 depending on whether individual i participated in the activity being considered; J,K,L,M,Q refer to the socio-economic categories that person i is in where J refers to a

category of the socio-economic variable 1, K refers to a category of the socio-economic variable 2, say Age, L refers to a category of the socio-economic variable 3, etc. U is a general level of participation in the activity under consideration.

B(1,J) is the effect of being in category J of the socio-economic variable 1, B(2,K) is the effect of being in category K of the socio-economic variable 2, and B(3,L) is the effect of being in category L of the socio-economic variable 3, etc. Finally C(i) is an error term.

It is possible that the kind of model just defined over-simplifies the interrelationships between the variables used to predict behaviour. It is likely that relationships between age and education exist that help one understand hunting participation. For example, having a high level of education and being old may mean something quite different from having a high level of education and being young insofar as participation in hunting is concerned. A person with a high level of education who is old may tend to come from an urban non-hunting background and thus have a very low probability of hunting. The "simple model" cannot be used to reflect the interaction effect between education and age affecting hunting just described. (TN 27 pursues the effects of interactions in another context.)

Consider a very simple model involving interactions. It is assumed that the participation in an activity can be explained by means of two socio-economic effects and by the interaction between them. Stated mathematically, individual behaviour is represented by the following equation:

(2) Y(i,j,k) = U + A(i) + B(j) + G(i,j) + e(k)
U + B(i,1) + B(j,2) + B(i,j,3) + e

WHERE Y(i,j) is the dependent variable,

B(i,1) is the differential effect of factor one taken at the level i;

B(j,2) is the differential effect of factor two taken at the level j;

B(i,j,3) is the differential effect due to the interaction at the level of factor one of the jth level of factor two;

e is a random error term, and its subscript;

k indicates a particular individual.

There are conditions which the B( ) coefficients must satisfy which the reader may review in a number of sources (eg. Reference 10, 12). However, the important point here

is that to have a great deal of freedom in how interaction effects are defined, the kind of formulation introduced here can be used. The formulation is such that many unknowns are usually computed to explain behaviour. U and (m-1), (n-1) and (m-1)(n-1) values of B(,1)'s, B(,2)'s and B(, ,3)'s respectively must be computed to define the model when all of the usual constraints on the model parameters are considered.

Now if in Equation 2, instead of just having three types of B( )'s one wants to have the 10 socio-economic variables for which effects were calculated in TN 12, then to have a model like the one just introduced with G(i,j) type interaction terms between every pair of variables there must be (10)(9)/2 = 45 such terms. For N variables the number of terms is (N)(N-1)/2.

Furthermore, just as for the one (i,j) interaction term there were (m-1) times (n-1) unknown B(, ,)'s to be calculated, the need for a "complete" model with 10 variables indicates that to define the model the number of parameters to computed is @E (n-1)(m-1) over 45 second order interaction terms. If one has estimated the effects just referred to they have not necessarily dealt with interactions adequately: one can consider three-way interactions that depend on the value that at least three variables in a model take, so there must be the (1,2,3), (2,3,4), (1,3,4) etc. interactions. If all three-way interactions between variables are to be consideredwhen there are N variables in a model the number of 3-way interactions are N(N-1) (N-2)/(3)(2)(1) which equals 120 for N = 10. As one might guess, for each of these there are (n-1) (m-1) (p-1) interaction B(, , ,)'s to be estimated where n, m and p refer to the number of levels of the three variables of a particular third order term. So it should be clear that one cannot simply insert all possible first, second, third etc. order interaction terms into a model and proceed to estimate parameters. When very many socio-economic variables are considered, the number of coefficients that would have to be estimated is so large that estimates could not be made on any existing computer. A more practical consideration is that when large numbers of parameters are to be estimated and these involve complicated interactions, the situation readily arises where, even when a very large data set is available, there are only one or two people who fit into certain classes on which there must be information to estimate parameters. What is even more of a problem is that there are often no people in certain classes. Still, there must be information if all the coefficients of a model are to be estimated.

Beaman and Renoux recognized the kind of problem just described when they began work on the research which eventually led to this Note. They tried to examine the differences between the model defined by Equation 1 and a much more adequate model which potentially takes into account interaction affects. The more adequate model that they chose to use was a model defined by the Michigan AID

Computer Program. (It is assumed that the reader knows how this program works. If this is not the case reference may be made to either TN 4 or TN 27, where they will find examples of its use. They may also refer to the original writings about the AID Program by Sonquist and Morgan (Reference 16)).

What was done by Renoux and Beaman to try to determine which interactions should be considered if a model was to fit a given set of data. Using the model defined by Equation 1 and using an AID model, predictions for individuals were written out on magnetic tape and became the focus for analysis in subsequent computer processing. The idea was that if cases could be identified where there were large differences between AID predictions and the analysis of variance predictions, these would provide a clue as to what interaction terms would need to be incorporated into a non-AID analysis of variance model. It was planned that the differences between these two predicted values could (for example) be examined by looking at the average value of it for various cross classifications of socio-economic variables.

Unfortunately, much work led to few results. As one might guess from the variance-explained values that have been reported in Table 1, the differences between AID predictions and analysis of variance predictions were highly variable. After much work, what was produced was a collection of AID analyses which showed that the Michigan AID Program explained much more variance than the simple model defined by Equation 1. There was almost no success in finding out which interaction terms should be introduced into the simple model to explain more variance.

The reader may find it interesting to look at Table 1 where they will find quite a comprehensive set of percentage of variance-explained values in which AID results on the 1969 CORD Study National Survey Data on Canadian Residents' Participation in Outdoor Activities are compared with the simple analysis of variance results. Analysis of variance results for 1972 are also given for reference purposes. Still, the R^2 values for 1972 ANOVA are comparable with the 1969 values because they were produced for persons 18 years of age which was the sampling universe in the 1969 study. Also they were produced for participation-non participation as the dependent variable and with the same independent variables. What one should notice from Table 1 is that, as a rule of thumb, use of AID resulted in explaining about twice as much variance as the use of analysis of variance, ANOVA. If one looks at the list of activities in column one of Table 1 they first see swimming participation in a city and they may note that for males 17% of the variance was explained using AID. The use of ANOVA resulted in 13% of the variance being explained. This is obviously not a 2 to 1 ratio but, then, for bird-watching for males, one notices the balance shifting as with ANOVA 2.5% of the variance is explained compared to 14% for AID. For outdoor photography for males, there is 12% for AID and 6% for ANOVA, which is

TABLE 1

COEFFICIENTS OF DETERMINATION, R^2'S,
FOR PARTICIPATION IN EACH ACTIVITY IN 1969 AND 1972,
FOR MALES AND FEMALES,
OBTAINED THROUGH ANOVA AND AID

	Males			Females		
	1969 AID	1969 ANOVA	1972 ANOVA	1969 AID	1969 ANOVA	1972 ANOVA
PARTICIPATION IN CITY						
1. Swimming	(.176)	.132	---	(.194)	.139	---
2. Nature/Bird Watching	(.142)	.024	---	(.075)	.016	---
3. Outdoor Photography	(.119)	.062	---	(.106)	.053	---
4. Visit Historic Sites	(.117)	.062	.051	(.084)	.042	.036
5. Visit Other Parks	(.108)	.060	---	(.108)	.049	---
6. Drive for Pleasure	(.086)	.050	.043	(.077)	.042	.045
7. Sightseeing Urban	(.105)	.066	.030	(.090)	.057	.025
8. Toboggan/Sledding	(.191)	.066	---	(.165)	.039	---
9. Picnicking	(.111)	.035	.018	(.102)	.049	.019
10. Walk/Hiking	(.146)	.091	.064	(.125)	.079	.059
11. Golfing	(.117)	.069	---	(.151)	.034	---
12. Ice Skating	(.208)	.159	.094	(.203)	.146	.059
13. Bicycling	(.171)	.081	.085	(.194)	.096	.102
PARTICIPATION IN COUNTRY						
14. Swimming	(.202)	.155	---	(.168)	.144	---
15. Nature/Bird Watching	(.075)	.014	---	(.088)	.032	---
16. Visit Historic Sites	(.096)	.056	.075	(.101)	.058	.065
17. Visit Other Parks	(.092)	.052	---	(.094)	.063	---
18. Drive for Pleasure	(.081)	.057	.056	(.095)	.060	.071
19. Sightseeing	(.101)	.073	.058	(.128)	.088	.063
20. Toboggan/Sledding	(.180)	.088	---	(.164)	.087	---
21. Picnicking	(.114)	.082	.092	(.133)	.096	.100
22. Walk/Hiking	(.121)	.065	.069	(.099)	.061	.063
23. Golfing	(.128)	.077	---	(.141)	.025	---
24. Ice Skating	(.139)	.056	.098	(.151)	.055	.072
25. Bicycling	(.148)	.046	.063	(.142)	.076	.066
OTHER PARTICIPATION						
26. Swimming	(.280)	.244	---	(.260)	.217	---
27. Tent Camping	(.120)	.069	.179	(.088)	.043	.100
28. Trailer Camping	(.061)	.022	.038	(.084)	.082	.036
29. Pickup Camping	(.156)	.019	.024	(.125)	.022	.024
30. Hunting	(.118)	.084	.091	(.150)	.035	.030
31. Power Boating	(.127)	.088	.071	(.112)	.064	.065
32. Canoeing	(.146)	.080	.094	(.094)	.036	.066

33. Sailing	(.131)	.053	.058	(.217)	.032	.061
34. Water Skiing	(.186)	.155	---	(.215)	.067	---
35. Nature/Bird Watching	(.068)	.017	---	(.081)	.029	---
36. Outdoor Photography	(.122)	.079	---	(.091)	.055	---
37. Visit Historic Sites	(.112)	.078	.092	(.101)	.073	.074
38. Visit Other Parks	(.101)	.076	---	(.105)	.077	---
39. Drive for Pleasure	(.102)	.066	.069	(.104)	.067	.095
40. Sightseeing	(.112)	.088	.062	(.130)	.099	.060
41. Climbing	(.095)	.037	---	(.130)	.029	---
42. Snow Skiing	(.208)	.125	.090	(.223)	.102	.087
43. Snowmobiling	(.160)	.103	.131	(.127)	.074	.103
44. Toboggan/Sledding	(.173)	.107	---	(.158)	.102	---
45. Picnicking	(.133)	.090	.101	(.148)	.115	.104
46. Walk/Hiking	(.142)	.086	.091	(.114)	.078	.089
47. Golfing	(.174)	.121	---	(.141)	.043	---
48. Ice Skating	(.233)	.193	.176	(.226)	.171	.128
49. Horseback Riding	(.198)	.102	.108	(.213)	.109	.114
50. Bicycling	(.156)	.083	.135	(.182)	.118	.147
51. Tennis	(.235)	.139	---	(.266)	.117	---
52. Fishing	---	---	.084	---	---	.053
53. Hunting/Fishing	---	---	.104	---	---	.058
54. Small Game Hunting	---	---	.077	---	---	.032
55. Large Game Hunting	---	---	---	---	---	---

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very close to the 2 to 1 ratio suggested earlier. A similar ratio holds for male use of Historic Sites and when one examines R^2 for the female use model for Historic Sites one sees that there is a ratio of .08 to .04 or 2 to 1. The results continue in a similar manner. In the odd case the ANOVA model is not too much "poorer" than the AID model while most results show that there was a great deal of variance to be explained which the ANOVA model does not explain.

When this situation was recognized the decision was made to involve other researchers in the attempt to find interaction effects of the magnitude that (it appeared clear from the difference between AID and ANOVA analyses) it should be possible to find. The researchers who took on this task were confronted with two problems. One was becoming familiar with CORD data study, and the other was developing a strategy for estimating interaction effects that would explain something like the amount of variance that it seems clear was possible to explain by interaction effects. This thrust of the research effort began with an exploratory analysis of the CORD Study 1972 National Survey data on Canadian Residents' Participation in Outdoor Activities, which data had become available since Renoux and Beaman had begun their work. The variables used from these data and their coding are shown in Table 2.

Initially, a number of equations were derived to give the researchers a feel for what second order interaction

TABLE 2

1972 CANADIAN'S PARTICIPATION IN OUTDOOR ACTIVITIES
VARIABLES USED IN ANALYSES REPORTED IN THIS PAPER

Variable Description	Original Value of the Variable	Recoded values used in analysis Reported in Table 3
I. AGE		
10 to 11 years	1	1
12 14	2	
15	3	
16 17	4	
18 19	5	
20	6	2
21 24	7	
25 29	8	
30 34	9	3
35 39	10	
40 44	11	4
45 49	12	
50 55	13	
56 64	14	
65 and over	15	
II. EDUCATION		
No formal	0	1
Some public school	1	
Finished public	2	
Some High School	3	2
Finished High School	4	3
Some tech-Senior College	5	
Graduate of tech-Senior College	6	
Some university	7	
Graduate of university	8	
III. FAMILY SIZE		
One (number of persons)	1	1
Two	2	2
Three	3	3
Four	4	
Five	5	4
Six	6	5
Seven	7	
Eight	8	
Nine	9	
Ten and over	10	

IV. INCOME			
0 - $ 2,999		1	1
3,000 - 4,499		2	
4,500 - 5,999		3	
6,000 - 7,499		4	2
7,500 - 8,999		5	
9,000 - 10,499		6	
10,500 - 11,999		7	3
12,000 - 13,999		8	
14,000 and over		9	
V. CITY SIZE			
500,000 and over		1	1
100,000 - 500,000		2	
30,000 - 100,000		3	2
10,000 - 30,000		4	3
1,000 - 10,000		5	4
Rural		6	5
VI. GENDER			
Male		1	0
Female		2	1

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effects were relatively important (see Reference 1). A methodology adopted for doing this was as follows:

(1) Each of several control variables, sex, age and education, was chosen in turn (see right-hand column of Table 3).

(2) Regressions were carried out to determine how the form of an equation to explain participation in hunting depended on the value of the control variable. For example, with age as the control variable, participation in hunting was predicted for persons 10 to 19 with a first indepenaent variable, sex = x(1), then for each of the other independent variables X(2) to X(5), resulting in the equations which follow and the others that would be written if one followed across the first line under the heading age:

P(of person 10 - 19) = C - .222*(1)sex relation
" = C - .088*(3)education relation
" = C - .000*(4)household size relation
" = C - .003*(5)income relation

WHERE C is a constant.

(3) Similar results were derived for other levels of the

control variables. Specifically, the age group 20 to 29 regressions were made giving equations like the ones above with the first three such equations having coefficients of X(1) x (3) and x(4) of -.0222, .021 and 007 respectively.

To comment further, as shown in Table 3 when age is the independent variable the equations obtained to estimate the probability of hunting for females is:

$$(3)\ \hat{p} = 0.064 - 0.012\ x(2)$$

and for males,

$$(4)\ \hat{p} = 0.341 - 0.052\ x(2)$$

Because the lines defined by Equations 3 and 4 are not parallel and have slopes that are significantly different at the .05 level, (the t-test was applied) it may be concluded that there is an interaction effect between sex and age. If there were no interaction effect then the difference between the sexes could be accounted for by a sex effect as in the two equations following:

$$(5)\ \hat{p}\ \text{(for example)} = \text{constant} + \text{male effect} + B\ x(2)$$

$$(6)\ \hat{p}\ \text{(for example)} = \text{constant} + \text{female effect} + B\ x(2)$$

WHERE B is a regression coefficient of age that applies to both sexes. But since as one can see from Table 2 variable x(2) has more than two values (eg. 1, 2, 3, 4, 5, etc.), one can write the following based on Equations 3 and 4:

$\hat{p} = .064 + .012 = .076$ for $x(2) = 1$ for a female

$\hat{p} = .064 + (.012)2 = .088$ for $x(2) = 2$ for a female
... etc. for all levels of x(2)

$\hat{p} = .341 - .052 = .393$ for $x(2) = 1$ for a male
... etc. for all levels of x(2)

The reader can readily confirm that the system of equations given above cannot be solved so that parameters are determined which make Equation 4 compatible with Equations 5 and 6. Having the two coefficients of .012 and .052 in Equations 3 and 4 makes it possible to reflect the fact that age has a much more pronounced effect on male participation in hunting than it does for females in the sense that young males may have a very high probability of hunting while older males have a very low probability similar to the general level of hunting for females. For females, what is necessary to reflect behaviour is that there be a quite drastic peak in probability of participating from almost nothing to maybe a .10 probability of participating. However, this peak in relative terms is

TABLE 3

METHOD 1: RESULTS OF PREDICTING HUNTING PARTICIPATION*
USING 1972 ORD NATIONAL SURVEY DATA

Independent Variables Used in Regression
with Selected Control Variables

"Control" Variables		Sex X(1)	Age X(2)	Education X(3)
Sex				
Males	(1)		-.052	.022
Females	(2)		-.012	.003
Age				
10 to 19 years	(1)	-.222		.088
20 to 29 years	(2)	-.223		.021
30 to 39 years	(3)	-.216		.021
40 years & over	(4)	-.101		.003
Education				
No Formal-Finished public school	(1)	-.135	-.026	
Some high school	(2)	-.250	-.054	
Finished high school and +	(3)	-.159	-.029	

"Control" Variables	Household Size X(4)	Income X(5)	City Size X(6)
Sex			
Males	.031	.020	.043
Females	.006	.012	.009
Age			
10 to 19 years	.000	.003	.045
20 to 29 years	.007	.004	.026
30 to 39 years	.010	.022	.027
40 years & over	.006	.022	.016
Education			
No Formal-Finished public school	.014	.034	.025
Some high school	.034	.027	.033
Finished high school and +	.006	.005	.021

* See the text for material on how to read the Table. Also one may note that significance test on differences between the B's were calculated but are not presented here because they play no role in the discussion or in arriving at the conclusions reached in this paper.

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not drastic in absolute terms since compared to males one sees that old males have almost no probability of participating whereas a young male has a 50% chance of participating.

This should make it clear why the great number of drastically differing slopes in Table 3 present clear evidence that there are interactions that should be considered in developing models to explain peoples' participation in outdoor activities. One could present statistical tests for the difference in coefficients, which is what was done in an earlier report on the data presented in Table 3. (See Reference 1). But this is not done since there are problems in comparing regression coefficients because they are inter-correlated, because in the results of including third and fourth variables are not considered and also because subsequent results presented in this paper are more important in confirming the magnitude and significance of interactions. Those who may wish to look at more material on what interactions there are and on their detection may refer to Renoux (Reference 11, 12) for specific examples that have to do with the data of concerned here. More general discussion is found in Reference 16.

A FIRST ATTEMPT TO DERIVE A FAIRLY GENERAL MODEL WITH INTERACTIONS

The step taken after the screening procedure just described to show the value in pursuing the matter of detecting interactions was one of introducing cross product terms into a linear model. Unless theory provides a clear guide, one starts with a model which offers some chance of success yet is also relatively manageable. In econometric research, and in some other areas where concerns with interactions arise, interactions are often first introduced by defining them in terms of a cross product of variables. So, if one assumes (as is done below) that 5 socio-economic variables are needed in an equation to explain people's behaviour and outdoor activities, one may write the following equation:

$$Y = b + B(1)X(1) + \dots + B(1)X(5) + B(1,2)X(1)X(2) + \dots + B(4,5)X(4)X(5) + e$$

WHERE X(1) is the age variable, X(2) is variable giving information on education, X(3) is a variable giving household size, etc. as indicated in Table 2, and B's are the regression coefficients for the different terms in the equation, and e is an error term.

In the preceding equation one obvious reason for keeping only the variables indicated (of those included in the 1972 Survey) is that these are variables which one can argue to be interval variables. If variables are to be multiplied as indicated in the equation it is important that the multiplication means something and it would obviously not mean something if (for example) one of the variables considered were (say) 10 arbitrary codes for occupation. If any of the variables are to be considered to be nominal variables one must return to the kind of framework introduced earlier which makes allowance for interactions where some or all of the variables in an analysis are nominal variables.

The preceding comment makes it clear that in certain respects the model designed above is not as general as the one introduced earlier. If variables are actually interval variables there is justification for multiplying. Then and only then it can be argued that the model multiplicative specified is the most appropriate model for data. But even when variables are interval one does not usually know whether the age-education effect can really be modeled by taking a multiple of age and education. Taking a multiple lacks the flexibility built into an analysis by simply grouping data into age-education levels in which one is willing to accept that behaviour will be fairly homogeneous. The multiplicative interaction terms which appear in Equation 3 and which are obtained by taking the product of, for example, X(1) and X(2) are only one guess (of an infinite number of guesses) as to how interactions should be specified. One could in fact introduce a number of terms of the type X(1) to the power A times X(2) to the power B where A and B are exponents. But a move in this direction is simply a move to increase the number of regression coefficients. As indicated earlier, arbitrary decisions of this nature that increase the number of coefficients ultimately result in complications in analysis that mean estimation problems cannot be handled computationally: when there are too many regression coefficients, they either cannot be estimated or are estimated very inaccurately. So, without theoretical justification, there is little point in considering powers of the variables, or considering products of the variables including three, four or five variables in a product. These products are simply analogous to the higher order interactions that it was indicated could be considered in elaborating on the more general model introduced initially.

Returning to the main theme, the hope was that when regressions were carried out to determine the unknowns in Equation 3, enough interactions would have been considered

ESTIMATED VALUE AND STANDARD DEVIATION OF REGRESSION COEFFICIENTS AND R^2's
FOR THE MULTIPLICATIVE INTERACTION EFFECT MODEL
TABLE 4

Activities (y)	x_1*	x_2	x_3	x_4	x_5	x_1x_2	x_1x_3	x_1x_4	x_1x_5	x_2x_3	x_2x_4	x_2x_5	x_3x_4	x_3x_5	x_4x_5	R^2 Without Interaction* R^2 With Interaction
MALES Tent camping	-0.029 (0.009)	0.076 (0.024)	-0.017 (0.022)	0.052 (0.020)	0.039 (0.023)	-0.003 (0.002)	0.002 (0.002)	-0.002 (0.001)	0.000 (0.001)	0.005 (0.003)	-0.005 (0.002)	-0.005 (0.003)	*** ***	-0.006 (0.003	*** ***	.161 .181
Pickup camper	-0.003 (0.004)	0.002 (0.009)	-0.002 (0.009)	0.004 (0.007)	0.017 (0.011)	0.000 (0.001)	0.001 (0.001)	*** ***	-0.001 (0.001)	*** ***	-0.001 (0.001)	0.001 (0.001)	*** ***	-0.003 (0.001)	*** ***	.004 .011
Hunting	-0.006 (0.009)	0.056 (0.023)	-0.012 (0.017)	0.008 (0.014)	0.100 (0.023)	-0.002 (0.001)	0.001 (0.001)	0.002 (0.001)	-0.004 (0.001)	0.004 (0.003)	-0.005 (0.002)	-0.001 (0.003)	*** ***	-0.004 (0.003)	*** ***	.076 .093
Canoeing	-0.017 (0.009)	0.052 (0.020)	0.002 (0.019)	0.017 (0.017)	-0.006 (0.020)	-0.003 (0.001)	0.001 (0.001)	-0.001 (0.001)	0.001 (0.001)	0.001 (0.003)	-0.001 (0.002)	-0.002 (0.003)	*** ***	-0.002 (0.002)	*** ***	.080 .089
Driving for Pleasure	-0.023 (0.011)	0.028 (0.021)	-0.019 (0.024)	0.006 (0.024)	0.050 (0.026)	0.001 (0.002)	0.003 (0.001)	0.002 (0.001)	-0.001 (0.001)	*** ***	-0.002 (0.003)	*** ***	*** ***	-0.003 (0.003)	*** ***	.026 .033
Snow Skiing	0.014 (0.007)	0.084 (0.017)	0.008 (0.016)	0.028 (0.014)	0.014 (0.016)	-0.005 (0.001)	-0.000 (0.001)	-0.003 (0.001)	-0.001 (0.001)	-0.007 (0.002)	0.003 (0.002)	-0.002 (0.002)	*** ***	0.002 (0.002)	*** ***	.079 .113
Snowmobiling	-0.027 (0.009)	0.040 (0.023	-0.035 (0.021)	-0.026 (0.020)	0.051 (0.023)	-0.004 (0.002)	0.001 (0.001)	0.003 (0.001)	-0.004 (0.001)	-0.001 (0.003)	-0.001 (0.002)	0.006 (0.003)	*** ***	0.003 (0.003	*** ***	.154 .176
Picnics	-0.057 (0.010)	-0.011 (0.027)	-0.037 (0.023)	*** ***	0.022 (0.026)	0.004 (0.002)	0.003 (0.001)	0.001 (0.001)	-0.000 (0.001)	0.005 (0.004	-0.004 (0.002	-0.004 (0.003	*** ***	-0.005 (0.003)	*** ***	.108 .120
Walking	-0.013 (0.011)	0.011 (0.027)	0.020 (0.026)	0.047 (0.023)	0.023 (0.027)	0.002 (0.002)	-0.001 (0.001)	-0.003 (0.001)	-0.002 (0.001)	0.004 (0.004)	-0.002 (0.003)	-0.003 (0.003)	*** ***	-0.005 (0.003)	*** ***	.111 .116

Bicycling	-0.050 (0.009)	-0.030 (0.022)	0.042 (0.020)	0.038 (0.019)	0.051 (0.021)	0.003 (0.001)	-0.001 (0.001)	-0.002 (0.001)	-0.002 (0.001)	0.005 (0.003)	-0.001 (0.002)	-0.004 (0.003)	*** ***	-0.009 (0.003)	*** ***	.399 .408
Fishing	-0.045 (0.011)	-0.003 (0.028)	-0.032 (0.026)	0.040 (0.023)	0.055 (0.027)	0.002 (0.002)	0.001 (0.001)	0.001 (0.001)	-0.001 (0.001)	0.006 (0.004)	-0.010 (0.003)	-0.001 (0.003)	*** ***	-0.003 (0.003)	*** ***	.108 .120
FEMALES																
Tent Camping	-0.030 (0.009)	0.071 (0.025)	-0.030 (0.020)	-0.011 (0.012)	0.014 (0.022)	-0.002 (0.001)	0.002 (0.001)	-0.000 (0.001)	-0.000 (0.001)	-0.001 0.003	-0.001 (0.002)	0.003 (0.003)	0.002 (0.002)	-0.002 (0.002)	0.002 (0.002)	.093 .104
Pickup Camper	-0.001 (0.004)	0.006 (0.011)	0.004 (0.009)	-0.003 (0.008)	-0.010 (0.010)	0.000 (0.001)	0.000 (0.001)	0.000 (0.001)	-0.001 (0.001)	0.001 (0.002)	*** ***	-0.001 (0.001)	-0.001 (0.001)	0.002 (0.001)	0.003 0.001	.014 .022
Hunting	-0.002 (0.005)	0.016 (0.012)	-0.007 (0.010)	-0.014 (0.009)	0.007 (0.011)	-0.001 (0.001)	0.001 (0.001)	0.000 (0.001)	-0.001 (0.001)	-0.003 (0.002)	0.001 (0.001)	0.000 (0.001)	0.002 (0.001)	0.000 (0.001)	0.002 (0.001)	.018 .027
Canoeing	-0.022 (0.006)	0.007 (0.012)	-0.004 (0.014)	-0.009 (0.014)	-0.036 (0.017)	*** ***	-0.000 (0.001)	-0.001 (0.001)	0.003 (0.001)	-0.003 (0.002)	0.004 (0.002)	-0.002 (0.002)	0.002 (0.002)	0.002 (0.001)	0.000 (0.002)	.074 .086
Driving for Pleasure	-0.050 (0.012)	-0.016 (0.031)	-0.015 (0.025)	0.011 (0.024)	0.030 (0.028)	0.002 (0.002)	0.002 (0.001)	0.003 (0.001)	0.002 (0.002)	0.006 (0.004)	-0.002 (0.003)	0.004 (0.004)	-0.002 (0.003)	-0.006 (0.003)	0.000 (0.003)	.069 .083
Snow Skiing	-0.001 (0.007)	0.058 (0.018)	-0.023 (0.014)	0.005 (0.014)	0.029 (0.016)	-0.003 (0.001)	0.001 (0.001)	-0.001 (0.001)	-0.001 (0.001)	-0.002 (0.002)	0.003 (0.002)	-0.004 (0.002)	0.004 (0.002)	0.001 (0.002)	0.003 (0.001)	.073 .093
Snowmobiling	-0.006 (0.009)	0.046 (0.025)	0.018 (0.020)	0.016 (0.019)	0.077 (0.022)	-0.002 (0.002)	-0.000 (0.001)	0.000 (0.001)	-0.005 (0.001)	-0.004 (0.003)	-0.003 (0.002)	0.003 (0.003)	0.000 (0.002)	-0.001 (0.002)	0.002 (0.002)	.122 .132
Picnics	-0.069 (0.011)	-0.027 (0.031)	-0.043 (0.021)	0.015 (0.018)	-0.039 (0.028)	0.004 (0.002)	0.005 (0.001)	-0.002 (0.001)	0.003 (0.002)	0.001 (0.004)	0.001 (0.003)	0.003 (0.004)	*** ***	-0.002 (0.003)	0.005 (0.003)	.107 .120

Walking	-0.035 (0.012	-0.018 (0.031)	0.000 (0.025)	-0.006 (0.024)	-0.014 (0.029)	0.002 (0.002)	-0.003 (0.001)	0.001 (0.001)	0.000 (0.002)	0.005 (0.004)	0.002 (0.003)	0.001 (0.004)	0.002 (0.003)	-0.000 (0.003)	0.002 (0.003)	.120 .126
Bicycling	-0.051 (0.009)	-0.003 (0.025;	0.004 (0.018)	-0.011 (0.020)	0.010 (0.017)	0.001 (0.002)	-0.002 (0.001)	0.001 (0.001)	0.002 (0.001)	0.005 (0.003)	-0.002 (0.002)	-0.002 (0.003)	0.006 (0.002)	*** ***	0.002 (0.002)	.287 .301
Fishing	-0.046 (0.010)	-0.057 (0.026)	-0.024 (0.021)	0.010 0.020	-0.002 (0.023)	0.005 (0.002)	0.003 (0.001)	-0.001 (0.001)	-0.000 (0.001)	0.003 (0.003)	-0.000 (0.002)	-0.001 (0.003)	-0.003 (0.002)	-0.001 (0.003)	0.005 (0.002)	.072 .083

The relation between the symbols used here and the english language names of the variables

x_1 indicates age or to abbreviate this (x_1, age), (x_2, education), (x_3, household size), (x_4, income), (x_5, city size).

Combinations $x_i x_j$ indicate the second order interaction terms between variables x_i and x_j. For the way the values of the variables were defined see the "original levels of the variable" in Table 2

*** Indicates that this variable was not considered in the regression because its explanatory power was too **small**.

that the variance explained would be increased substantially over what was explained in the Equation 1 regressions. Table 4 shows the results that were obtained. One sees in the right-hand column that there was a nominal increase in the value of R^2 when the interaction terms were included in the model. For example, when one looks at the results for a male model for tent camping, one sees the R^2 was increased from about .16 to .18.

In the first regression for which R^2 is reported five parameters were estimated, whereas in the second 15 were estimated. If the interaction effects were not important, the increase in variance explained would be that explained when the coefficients of the X(i) X(j) terms were not related to systematic differences in behaviour but simply "explained" random error. In practical terms the introduction of these terms should have explained about 10/(number of cases - 15) which is about .5% of the variance that remained to be explained. But in fact the 2% explained is much in excess of the approximately .5% of the variance that would have been explained by chance. An appropriate F test for the significance of this variance explained is the F test with 10 and infinite number of degrees of freedom:

$$F(10,\text{infinity}) \text{ approx} = (2000/10)(.015/.985) = 3.04$$

which is significant since it exceeds the .05 level of 2.54.

In a sense there is no need to go into this kind of statistical test to see that the results of introducing the interactions are significant. The very fact that many of the regression coefficients for the product terms are twice their standard deviation indicates significance at the .05 level. One may notice that the coefficient with value -.00291 for the tent camping model for males is almost twice its standard deviation, which is .00160. Similarly the coefficient for the X(1) X(4) term, for the X(2) X(4) term and for the X(3) X(5) term are also substantial in comparison to their standard deviations. Also, if there are co-linearity problems, the standard deviations are "exaggerated", causing the values of coefficients to be small in comparison.

Obviously there is the odd coefficient for the interaction terms that has a magnitude more than three times its standard deviation and which will allow one to accept with more confidence. This can be considered to relate to the conservation two times rule that Draper and Smith (see Reference 3) have suggested be used in some tests of significance in doing regressions where the distributions are in doubt.

It could still be argued that since so many coefficients were computed, the significant ones only reflect chance occurrences. This can be disproved, but the arguements are not presented here. The fact that far more than 5% of the interaction coefficients are significant at

the .05 level is really all the proof that is needed.

Table 4 shows the parameters of some models that are highly statistically significant improvements over the regression models without interaction terms. However, one may wonder how significant the improvement of an R^2 from .16 to .18 is, compared to what could be achieved. When one compares the results of using the AID program with the "simple" regression results, there may be some surprise that introducing the interaction has explained so little variance. There is certainly no basis for a feeling of elation because the interaction results are statistically significant. This is particularly important in understanding why developing the kind of equations for which coefficients are presented in Table 4 was not pursued. The researchers, who were trying to improve on the simple model, saw that the improved model, though it offered a significant improvement, did not appear to offer the improvement to be expected if the variance that was available to be explained by interaction was being explained. When R^2 was (on the average) being increased by 10 to 20%, getting in the proper interaction terms would increase it by 100%. Something else needed to be done. Or did it?

VALIDATION OF AID RESULTS

If it does not appear that a predictive model is explaining the variance that it should, an obvious first step might appear to be to incorporate more terms into the model. But concerns about doing so have already been raised. Another line of inquiry is to determine whether in fact the model is doing well but that the limit of the R^2 which might be attained has been assessed incorrectly. The possibility is that the AID program, because of the way it is set up to search for variance, finds variance even if it cannot be explained by a model that is perfectly appropriate to explain it must be considered. By going to a simulation approach one knows what the true model is because one has been used to generate observations and one can then determine by how much (if at all) AID indicates an excess of variance explained over what can be expected to be explained by a model that is appropriate to the data.

It was decided to generate a dependent variable Y having 0 and 1 values indicating participation or non-participation and of the general form of Equation 1. In the simulation, five variables with four levels of each variable were defined. Values of Y around a grand mean of one-half were generated for 1500 cases. The simulation formula for regression coefficients was:

$$B(i,j) = (1/4)((i - 2.5)/1.5)/2[1-j]$$

WHERE j indicates the variables 1 to 5 and i indicates the level of the variable that an individual has, 1 to 4.

These are the coefficients in:

$E(y) = U + B(j,i)X(j,i)$ when $U = 1/2$

A random number routine was used to independently and randomly generate the levels of the 5 independent variables that characterize an observation. For example, (1, 3, 4, 1, 2) could define a person for whom an observation was made. For this person:

$$E(y) = (1/2)+(1/4)[(-1)+(1/3)(1/2)+(1)(1/4) + (-1)(1/8)+(-1/3)(1/16)]$$

In the above one has (1/3)(1/2) as what could be described as the third term in E(y) because the person has level 3 of variable 2. The (1/4) which is in each B(i,j) appears as a factor that multiplies all five B(i,j)'s. An observed Y was generated using random numbers so an observation 1 had a probability of E(y) and 0 a probability of 1-E(y).

In generating collections of numbers like (1,3,4,1,2) for all variables, it was considered that people were in levels 1 to 4 of each variable in the ratios 4/3/2/1 so that 4 times as many people were assigned to level 1 of a variable as to level 4. This was done using a random number routine so that for a variable X(i), if the random number generated was under 1/10 a person was assigned to level 4 of the variable X(i). If the random number was between 1/10 and 3/10 the person was assigned to level 3; if it was between 3/10 and 6/10 a person was assigned to level 2; and if it was between 6/10 and 1 the person was assigned to level 1.

The results of the simulation study are shown in Table 5 where the ANOVA figures are calculated on the basis of theory (because there was no need to estimate these results). The results for AID analysis are the average results for 100 analysis runs. As can be seen the AID model when applied to the given data to which another model is structurally appropriate explains only slightly more variation than the model which is actually appropriate to the data, the difference in explanatory power only being noticeable in the third figure of R^2. The difference in R^2 is truly minimal and certainly much less than the difference between the ANOVA model and AID results reported in Table 1.

Thus the difference in the R^2 suggested by an AID run and the R^2 found using regression models should not be large if the regression models are truly appropriate to the data. So, it can be concluded that there is good evidence that for models very similar to those developed using the CORD Study data, the AID program detects relatively large sums of squares which almost certainly do not relate to spurious interactions. It also appears safe to say that the results provide a clear indication that there is a great deal more variance to be explained in the CORD Study data than was explained by using the model with interaction terms for which results are presented in Table 4. Introducing the further complication of interaction terms only explained

about 20% of the variance that should be explained if appropriate interaction terms had been considered. If the models had been good, R^2 should have gone up 100% on the average, not just by 20% as was the case. There may be many more interactions to be considered and/or the interactions may be a different type from those which are implicit in the formulation that was used.

TABLE 5

SUMMARY RESULTS OF AID AND ANOVA ANALYSES
OF SIMULATED DATA TO WHICH AN ANOVA MODEL
IS STRUCTURALLY APPROPRIATE

	MODEL	
	AID	ANOVA
(1) Total sum of squares	336.2792	336.2792
(2) Between sum of squares	59.3586	56.8900
(3) Within sum of squares	276.9206	279.2892
Mean of y	0.32733	0.3393
S.D. of R^2 =(2)/(1)	0.170	0.168

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The validation of AID results has only brought one back to the point of seeing that little was gained by cross product analysis but that much must be achieved if models are to adequately explain the relation between socio-economic variables and participation.

DISCUSSION

The preceding commentary in some sense presents a logical sequence which has occured in considering how models should be developed that may be used to explain peoples participation in activities in terms of their socio-economic characteristics. However, one very important practical question remains. When the logical sequence has been built up it shows that interaction terms should be considered in developing the kinds of model for which applications have been introduced in TN 12 and 13. Should a simple Equation 1 model be applied in the way indicated in the TN 12? In other words, should estimates be made for sub-areas of Canada based on National or Provincial data using simple ANOVA models or is this a dangerous practice? If an area of Canada

is very similar to the nation as a whole then one can see why one could use a model which is deficient in certain respects. Even if interactions are not considered, predictions would be corrected in a way that "relatively" appropriate data suggest they should be. However, when one recognizes the disparities in Canada in terms of what activities can be carried out, what differentials there are in terms of age, income etc. then the dangers inherent in using parameters for a National model in making predictions for a sub-area of the country are obvious. The area for which predictions are made may well be such that the National parameters are not relevant. One must be very concerned that the National parameters are only aggregate parameters with no particular relevance to any sub-areas that deviate substantially from the national average.

In the context of this paper the crux of the concern is not whether there are disparities within Canada but whether the effects of these disparities on peoples' participations in activities can be adequately modelled only considering first order effects: or if second order effects are considered if regional differences are "explained" by these and first order effects or etc. for third order effects.

One is confronted with the fact that the simple analysis of variance model appears to only tap half the variance that should be explained by socio-economic characteristics. At this point in time it is impossible to say how much this deficiency of a model influences predictions by resulting in a bias in the accuracy of predictions that are made. Actually, there is one area of model deficiency on which comment can be made. In TN 29 supply factors are derived that show that, for at least some activities, ANOVA equations should include not only socio-economic variables, but a measure of supply in the various areas in which people live for whom predictions are made. These supply factors can be visualized by:

$$\text{Probability of participating} = U + \text{socio-economic effects} + \text{regional supply factor}$$

Now, even though supply factors may only account for 1/5 the variance that socio-economic characteristics do, one need only look at TN 29 to see that (for example for skiing) the supply factors for Alberta and B.C. are very important in making correct predictions of participation.

The problem with supply effects is that they should be considered but they may not be known or may only be known inaccurately. As indicated in TN 29 massive amounts of data are required to estimate supply effects from participation data and there is no known way now to calculate them based on inventory information on what facilities there are. Developing formulae for computing supply factors based on "resource inventory" data would appear to be very important if good use is to be made of ANOVA models.

On another matter, the preceding comments of AID ignore an important point. That is that there are kinds of

interactions which it is convenient to consider and there are kinds which it is extemely inconvenient to consider. The reader may well ask himself why it is not proposed that one forget about using the ANOVA models to make predictions (Cesario gives an example of using an AID model to make predictions in TN 4). The reason not to use AID models in making predictions is that they require detailed multivariate information on every individual and data on every characteristic of individuals. Such information is available in Canada on the Census GRDS System but to process this information on an individual basis involves making special arrangements with Statistics Canada so that confidentiality is not violated. It would be a costly operation. It would be particularly cost-inefficient if the gains in accuracy of predictions were not such that they could be justified. This could occur because, though predictions were slightly more accurate than ANOVA predictions in terms of their variance, they may still be so biased by inability to consider supply effects so that the answer predicted is not significantly closer to the true participation values than for less reliable predictions: the problems may be validity, not reliability.

Incidentally, from a cost-effectiveness perspective one would never consider making predictions using all available census data unless the parameters in a model were accurate enough to justify knowing population characteristics very accurately. In making predictions one only needs data on a sub-set of the population that defines the characteristics of the population much more accurately than the regression parameters. But, this point is not pursued here because it is taken up later in this discussion in a more general context.

Even if it is not desirable to use AID to make predictions, one may not see what the problem is in considering any arbitrary interaction between 2, 3 or more variables. The problem is that if there is an age education interaction effect for males, one must be able to specify how many males there are in a specific age-education group to compute the product $B(i,j)$ $h(i,j)$. This may not be especially difficult in some cases. Census data may possibly be used if one's concern is with the past. However, to get information on males by education for small areas of Canada is not something trivial. When other variables are considered on which data are collected on a sample basis the problem is compounded because even if the Census table desired is produced for provinces (and many three and four variable tables would not be) the data for small areas would have to be obtained by special requests for tabulations. If Statistics Canada agrees that these should be produced it takes time and the cost is high. Furthermore, it does not take much background in demography to know that predictions of the number of males in a particular age-education group for sometime in the future are not something that is made on a routine basis. In fact, it is only recently that models have been developed in which these kinds of projections play

a role. Usually, rather awkward formulae have been developed to generate the kind of multivariate characteristics called for if one is to make projections of the number of males in certain age-education groups in (say) the year 1990. One certainly should be careful in introducing interactions into a model if they are ones for which one cannot make reasonable projections: that is if the object of the exercise is to use a model to predict participation at some future time.

The preceding paragraph raises an issue taken up in TN 6. If the accuracy of a model's parameters is not all that is of concern in using a model and if one is concerned about both the accuracy of the B(i,j)'s and the n(i,j), the number of people in certain socio-economic groups, one should not concentrate on the B(i,j) and problems with interactions when the really large inaccuracy is in the n(i,j)'s which must be estimated!

When it comes to the matter of modelling using a small sample, one should look at the results presented in TN 6 and recognize that unless sample sizes are in the order of 4,000 or larger then predictions made using the regression results are going to be extremely inacurate. If some kind of statement is to be made about participation by people in a small area in a certain activity, a reasonable choice may be to use a telephone survey or some other means of obtaining information quickly rather than making predictions using modelling results. Given all the objections that can be raised to telephone surveys, etc. little is gained by replacing the results of such work with results produced using a theoretical model when it can be shown that these results have errors which are probably far greater than any errors that arise in a well planned telephone survey.

Turning to a quite different and less practical matter, an analyst often wants to use regression results to draw some kind of conclusions about what is happening in the world or in the universe that he is considering. The failure to introduce interaction terms into a model when in fact they relate to about 50% of the variance that could be explained by the model can certainly be expected to distort the picture that an analyst would draw from the coefficient which he estimates.

In closing this discussion one should note, as indicated in other Notes, that if one is calculating people's expected probability of participation in an activity then the very fact that probabilities are being estimated suggests that each individual observation has a unique variability associated with it. This heteroscedasticity problem, which is encountered in dealing with dependent variables which cannot be accepted as having a constant variance, is the topic of concern in the Cicchetti and Smith paper included as an appendix to this volume, and there is also useful commentary in the review of Chapter VII.

CONCLUSION

This article has presented some rather distressing findings about the structure of models commonly used for predicting participation and frequency of participation in outdoor activities. It is clear that interaction effects play an important role in explaining peoples' participation in outdoor activities. Neglecting such factors could result in errors arising which would méan that estimates made have substantial biases. However, as pointed out, there is no evidence as to whether (once supply factors are taken into account) biases tend to be very small because the people to whom interaction effects apply tend to be very homogeneously distributed among the population. There has been no research which shows whether or not there are some sectors of the population for which interaction effects are extremely important and others for which a simple model would be quite appropriate. Until such research has been carried out to clarify this matter it must be recognized that there are dangers in making predictions using an ANOVA model.

J. Beaman and R. Gillespie

The major complication in measuring recreation demand is that it does not exist as an entity independent from existing supply: there is a functional relationship among the demand-controlling forces and recreation opportunity. Understanding this relationship is a difficult matter, complicated by the fact that even the opportunity side of the equation is not clearly defined. There exist problems of lack of a means of measuring "opportunities" for activities. In part, this relates to a lack of adequate means of dealing with the problem of differences in quality of resources and opportunities. But even if this problem of quantification could be overcome, an effective measurement of opportunity must be a measure of perceived opportunity, which could differ widely from what opportunity (in fact) exists.

The recreation demand of a given community is never static, but constantly changing in response to variations in the physical and technological, institutional, and socio-economic forces which are its determinants. Demographic variables are only a few of the multitude of causal factors affecting participation. "Faddism", rapid taste changes, and new technological innovations, are just a few of the many other factors which make the determination of the level of recreation demand a very elusive objective.

The final complicating factors in the measurement of demand for recreation facilities, according to Burton (see Reference 5) are concepts of substitute demand, diverted demand, and latent demand as they apply to recreation. Substitute demand occurs when demand for a certain kind of a facility is drawn away to a completely different facility which, for some reason, attracts the users of the first (see TN 37). Diverted demand, on the other hand, comes into play in the situation where demand is diverted from one certain kind of facility to a new source of supply. Latent demand is that which exists but is not being satisfied due to restricting factors such as income or lack of opportunity.

Having read the preceding comments the reader may well ask: "What value is TN 12 when it has to do with applying a model to estimate use at some location and possibly at some future time, ignoring most of the demand factors just cited?". As the authors admit in the Note, the general procedure they endorse is not an original contribution by them. The importance of the Note to the CORD Study is that it provides an example of how something may be done using the CORD Study data and that familiarity with the ideas presented are particularly important in understanding TN 6, 13, 20, 29 and 36.

This suggestion that TN 12 presents a rather simplistic model does not imply a similar "condemnation" of TN 6, which chose a simple example of how to calculate accuracy of estimates to illustrate a general principle. The Note is not

profound mathematically and possibly the authors should be faulted for not making clear that the approach for assessing error can be used in the way described for any model that is linear in terms of its coefficients. This includes the kind of models described in TN 13 and 20. As well, the method can be used with models such as the Rutgers model (Chapter I) or the models described in TN 29, both of which have supply factors.

One can fault TN 20 because it deals only with gaining a better explanation by introducing interactions between socio-economic variables. Possibly it would have been more relevant to try to determine whether institutional factors, supply factors or technological change were more deserving of attention. Certainly the notes in this chapter do not adequately bring to the readers attention the fact that other Technical Notes bring out the following considerations:

(a) Faddism and technological change in predicting activity (TN 13).

(b) The importance of supply (TN 29).

(c) The importance of substitutability or alternatives (TN 3 and TN 37).

(d) The importance of the group a person belongs to (TN 10, TN 13 and TN 32).

Probably the most serious fault of the above notes is that the models proposed are formulated ignoring the multidimensional nature of peoples' participation in activities: identification of "types of recreation" may facilitate the prediction of future demand for various recreation facilities. To quote Burton, "If participation in any particular pursuit can be linked to participation in other pursuits, and to certain socio-economic characteristics, then, as the socio-economic characteristics of a given population change, it should become possible to predict, at least in general terms, how participation in given pursuits and groups of pursuits will change". Burton's idea (but not method) is endorsed here. Groups of people with common participation patterns (as derived in TN 10) are (as claimed in TN 13 and TN 32) a more stable base for forecasting than participation in individual activities, because participation rates in various activities for such a group reflect definitive behavioural characteristics of people with that "activity package". If, for example, due to a reduction in personal disposable income, an individual changes his participation from one activity to another, it is not very likely that he will totally abandon his activity package but rather he will concentrate his activity more in his less expensive activities. This change then, whould not affect forecasts based on "groups as much as it would those based on individual activities.

Given the negative comment on the articles in this chapter, it is still the view of the reviewers that the chapter is a valuable collection of articles. No easy do-it-yourself guide is known to be available for making use of analysis of variance results in predicting participation in activities (e.g. as in TN 12). And having an article (like TN 6) that points up the importance of making error estimates is constructive. The numerous studies where predictions of the volume of park use or some other activity are made with no hint of the error involved are abundant evidence of the need for a method of error estimation. Finally, conditional on the fact that TN 20 is not definitive in any way on when a model is good enough, it has at least shown how bad some models are and how they can be improved. It is to be hoped that this first step will result in other research that will produce really good models.

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CHAPTER V

SUPPLY ANALYSIS

INTRODUCTION

Through reading Chapter I, it is possible to see that Knetsch, in presenting a design for the Canadian Outdoor Recreation Demand Study and in developing a further proposal for data analysis, saw the "analysis of supply" as very important. So it will not be surprising to find out that (contrary to what its number may suggest) TN 16, "Considerations in Defining a Methodology for Calculating the Supply of Outdoor Recreation", was completed early in the CORD Study. However, it may be surprising to find out that this study was not really prompted by Knetsch's design for the CORD Study but rather reflects Ontario's work on the TORPS, Tourism and Outdoor Recreation Planning Study. Incidentally, this note does not reflect the current status of "research" on measuring supply. Provincial committees on supply measurement have continued to meet (to 1976) and in 1974 one full-time research officer was appointed to be responsible for Ontario's supply measurement project.

CORD Study Volume III (as is commented on in TN 5) makes it clear that lack of compatability in CORD Facility Inventory data between the Provinces was a factor that forced a particular direction on "national scale" supply analyses. As the reader has seen in Chapter I, Knetsch proposed that Canada follow the "Rutgers' methodology" in developing models. This involves introducing measures of the level of supply into "origin" models such as that presented in TN 12. But in 1971, after expert advice from several persons including a member of the Rutger's research group (Cicchetti), it was concluded that because of (1) variation in types of facilities on which information was collected and (2) variation in the years to which data were relevant (from 1968 to 1971), using the Rutger's methodology to develop a Canadian model had questionable value.

By 1971 Cheung's development of a day-use model had raised questions about how the availability of "alternative supply" around a given city or park affects the use of a given unit of supply, e.g. use of a given park. The need to answer such questions prompted the preparation of TN 3. Strangely enough, work on this note started in early 1972, but only in 1974 did the interrelationships between a number of issues become clear enough that the authors felt free to complete the note in its present form.

Only when the reader of this volume has completed Chapter X will he see how CORD Study researchers who prepared TN 29, by detailed study of the Cesario model, eventually saw a unity between origin and destination models. Work on TN 5 followed by work on TN 11 and 33 made clear that there was a need for a work like TN 29. However there is no need to pursue details. It has long been recognized (e.g. see Veal's comments in chapter 13 of Reference 2) that people do not react linearly to the "amount of supply" for participating in an activity available to them. Cheung's use of an alternative factor involves the recognition that geographic configuration of supply and the "attractivity" of different units of supply affect behaviour. To cite but two examples, TN 30 and 37 introduce analysis and literature on the effect that the availability of alternative activities in which to participate has on participation in a given activity. So there was good reason to try and get information from an "origin perspective" about how people responded to the complex supply situation in which they lived out their daily lives. The search for such information was undertaken in the way described in TN 29.

CORD STUDY TECHNICAL NOTE 16

CONSIDERTIONS IN DEFINING A METHODOLOGY FOR CALCULATING THE SUPPLY OF OUTDOOR RECREATION

M. Cox

ABSTRACT

The purpose of this paper is to suggest ways of measuring supply with supply defined as the number of user days of recreation that facilities or a land area are capable of supporting in a year. Relevant terms are defined such as: space standard, turnover rate, institutional factor (constraint) etc. Then in terms of the concepts introduced various "supplies" are defined and explained. These are:

1. Theoretical Potential Supply - This is the supply of recreation that would exist in an area if all land and facilities were developed to handle the participation that the area is capable of supporting while continuing to maintain the quality of the environment.

2. Present Potential Supply - Present potential supply is calculated in the same fashion as theoretical potential supply except that it is the present degree of development which is considered in the definition.

3. Present Usable Public Supply - Not all of the potential supply of recreation in an area can be considered available for consumption by the public because of either accessibility or ownership constraints. Present usable supply is, therefore, calculated in the same fashion as present potential supply.

4. Effective Supply - Effective supply is present usable supply adjusted for (i)the institutional constraint imposed by present working habits, (ii) legal constraints which restrict the days available for certain types of recreation, and (iii) competing land or water use.

Examples of how to compute the supply measures proposed are presented.

This report was prepared early in a continuing Ontario project on supply measurement. Many problems in measurement and refinements to the basic ideas behind the supply project were being documented even as the paper was completed in 1972.

INTRODUCTION

When deciding where and in what activities, recreation dollars should be invested, it is important to look at present supply, participation and demand. The purpose of this paper is to suggest ways of measuring supply, with supply defined as the number of user days of recreation that the facilities or land area are capable of supporting in a year. When interpreting what is meant by a user day, it should be kept in mind that it is the kind or type of experience rather than the duration of the outing that is important and that, therefore, the time dimension attached to a user day is flexible.

Definition of Terms

Before discussing definitions of supply, it is necessary to introduce a few terms.

1. Space Standard

    This is the term used in referring to the number of recreationists that can be accommodated per unit of area without appreciably destroying the quality of the recreation experience and/or the quality of the environment (for some class of user). These standards can run the entire gamut of sophistication from, for example, a standard of X linear feet of beach per swimmer to a standard that varies with the OLI standard of the beach. (OLI refers to the Ontario Land Inventory which is an inventory which involves some basic modifications to the Canada Land Inventory.)

    It may be that the environmental quality standard is reached before the point where the quality of the experience is destroyed. If this is the case, the space standard established for the quality of the environment should be the standard used in the supply calculation.

2. Turnover Rate

    More than one person or group can engage in the same activity at the same location during different periods of a day. For example, one group can occupy a picnic table in the morning, another in the afternoon and possibly a third group in the evening for a turnover rate of 3. In other words, there may be three user days of picnicking available on a single day.

3. Institutional Factor

Most people who are employed follow the normal pattern of working during the week and taking the weekend off. Therefore, although a similar number of user days of recreation are usually available on each day of the week, user days of supply on weekends are of more value than user days on weekdays since most people are not free to use them during the week. In the author's view, this implies that a reduction factor should be used to deflate the weekly estimate of supply (K factor).

4. Ownership and Accessibility (Location)

There are many types of ownership of recreation land and/or facilities and this can affect the supply of recreation available to the public. The ownership categories that have been used in the 1973 Ontario Tourism and Outdoor Recreation Planning Study (see Reference 21) for the Household Recreation Survey are as follows:

A. Crown Land.

B. Provincially operated:
(i) Parks, recreation areas, public hunting and fishing areas;
(ii) Other public facilities.

C. Conservation Authority operated:
(i) Parks,
(ii) Open Spaces.

D. Municipally operated:
(i) Parks and open space,
(ii) Other municipal facilities.

E. Federally operated:
(i) Parks,
(ii) Other public facilities.

F. Private land open to the public.

G. Private land not open to the public.

Similarly, many recreation opportunities are inaccessible because of locational constraints. For example, a lake might potentially provide user days of fishing, however, if it can not be reached without great difficulty then this should be recognized in the definition of usable supply. On accessibility and travel, see TN 14.

5. Legal, Seasonal and Weather Constraints

Not every day of the year is available for each activity because of seasonal and legal restrictions. For example, swimming and boating are summer activities. Snowskiing and snowmobiling are winter activities. Most types of hunting and fishing are restricted by law to certain periods of the year. Weather conditions also restrict the days available for particular activities even when these activities are in season. Weather actually involves a different nature of constraint on supply than legal restrictions but for the purposes of this preliminary discussion these factors are considered together. Basically, if one wants he can often participate legally in spite of the weather. The same cannot be said regarding legal constraints.

6. Competing Land or Water Use

There is often a conflict amongst recreation uses on a given tract of land or water. For example, water used for waterskiing interferes with the simultaneous use of that water for boat fishing. Multiple use of areas in a topic that has received substantial discussion. Pearse's (see Reference 16) article "Principles for Allocating Wildland Among Alternative Users" is an example of a growing literature. There are a variety of issues regarding non-consumptive use to which one may refer. (See Reference 13, 14 and TN 23.)

Definitions of Supply

The author believes that four methods of measuring supply should be considered.

1. Theoretical Potential Supply

This is the supply of recreation that would exist in an area if all land and facilities were developed to handle the participation that the area is capable of supporting while continuing to maintain the quality of the environment. In other words, theoretical potential supply is the supply that would be forthcoming if an area were developed to the maximum that its OLI capability ratings allowed. The possibility of maintaining the quality of the environment at a given level is the fundamental issue. Theoretical potential supply is calculated for non-consumptive types of

recreation, such as boating, swimming, picnicking, as the product of the area available for a recreation activity, the turnover rate, the space standard appropriate to the highest degree of development, and length of the season in days with length of season being defined as the number of days the activity can be participated in each year. (The length of season definition for theoretical potential supply includes bad weather days during the season but ignores legal constraints.) So non-consumptive is used here in a special way because in the long run even picnicking and boating can be consumptive. The definition of potential capacity assumes that management can preserve a nonconsumptive balance by applying sufficient capital to maintain a given quality of the environment.

In the case of consumptive activities such as hunting and fishing, the theoretical potential supply calculation recognizes biological productivity and catch per user day based on the assumption that the lands and waters are stocked to their biologically maximum level. Finally, it is assumed that all land and facilities are physically accessible and open to the public.

2. Present Potential Supply

Present potential supply is calculated in the same fashion as theoretical potential supply except that it is the present degree of development which is considered in the definition. (OLI suitability is considered to be a valid index of present degree of development.) Space standards appropriate to the present degree of development are used in the calculation.

3. Present Usable Public Supply

Not all of the potential supply of recreation in an area can be considered available for consumption by the public because of either accessibility or ownership constraints. Present usable supply is, therefore, calculated in the same fashion as present potential supply but includes only land and water that is both open to the public (i.e. TORP categories A to F) and accessible (this would usually mean the area can be reached by car and/or after a short walk).

4. Effective Supply

Effective supply is present usable supply adjusted for (i) the institutional constraint imposed by present working habits as discussed at the beginning of this paper under item 3 (Institutional Factors), (ii) legal constraints which restrict the days available for certain types of recreation, especially hunting and fishing and (iii) competing land or water use.

CONCLUSION

This paper presented a discussion of a number of concepts that are of importance in developing an understanding of the supply! for outdoor recreation. The ideas presented here have played an important role in the development of the Ontario Day-Rec and TORP models and are used in "A Method of Allocation of Recreational Supply to Urban Centres". (See TN 17.)

Ontario's planning depends very heavily on an increasingly sophisticated understanding of the nature of recreation supply. As analysis proceeds according to the requirements of a planning-programming-budgeting system, consideration of tradeoffs between alternative supplies for a given activity and tradeoffs between activities having common or disjoint supply are becoming increasingly important. It is imperative that the recreation planner develop a thorough understanding of the nature and composition of supply.

APPENDIX

The purpose of this appendix is to summarize the definitions of supply that have been presented and to show by means of example how these alternative supplies might be calculated. Factors shown in capital letters distinguish a method of measuring supply from the preceding method.

<u>Theoretical Potential Supply</u>

- development to level that OLI capability rating indicates

- function of area available, SPACE STANDARD CONSISTENT WITH MAXIMUM DEVELOPMENT, turnover rate, length of season, (excluding legal constraints)

<u>Present Potential Supply</u>

- present degree of development considered

- function of area available, SPACE STANDARD

CONSISTENT WITH PRESENT DEGREE OF DEVELOPMENT, turnover rate, length of season (excluding legal constraints)

<u>Present Usable Supply</u>

- present degree of development considered

- function of area available, space standard consistent with present degree of development, turnover rate, length of season (excluding legal constraints), ACCESSIBILITY and LAND AND WATER TENURE

<u>Effective Supply</u>

- present degree of development considered

- function of area available, space standard consistent with present degree of development, turnover rate, length of season (INCLUDING LEGAL CONSTRAINTS), accessibility, land and water tenure, INSTITUTIONAL CONSTRAINTS and COMPETING USES ON LAND AND WATER

Table 1 is a tabular presentation of the above, and Table 2 is an example of how different types of supply may be calculated.

TABLE 1

SUPPLY CALCULATIONS CONSIDERATIONS*

Considerations	Supply Categories: Theoretical Potential	Present Potential	Present Usable	Effective
1. Potential Stage of Development	X			
2. Present Stage of Development		X	X	X
3. Area Available	X	X	X	X
4. Space Standard	X	X	X	X
5. Turnover Rate	X	X	X	X
6. Length of Season (includes bad weather considerations)	X	X	X	X
7. Accessiblity (% accessible)			X	X
8. Ownership (% open to public)			X	X
9. Institutional Constraints				X
10. Length of Season Recognizing Legal Constraints				X
11. Competing Land & Water Use				X

* X Indicates that an item is considered in the calculation of supply.

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TABLE 2

SUPPLY CALCULATION AN EXAMPLE

Supply Category/ Considerations	Potential Stage of Development	Present Stage of Development	Area Available	Space Standard	Turnover Rate	Length of Season (Includes bad weather considerations)	Accessibility (% Accessible)	Ownership (% Open to Public)	Institutional Constraint	Length of Season (Legal Constraints Considered)	Competing Land and Water Use	Total Supply (User Days) Class 1	Class 2	Total
Theoretical Potential Supply	X		100	5	2	90						90,000		
	X		200	3	2	90							108,000	198,000
Present Potential Supply		X	100	3	2	90						54,000		
		X	200	2	2	90							72,000	126,000
Present Usable Supply		X	100	3	2	90	75	50				20,250		
		X	200	2	2	90	75	50					27,000	47,250
Effective Supply		X	100	3	2		75	50	.75	90	X	15,188		
		X	200	2	2		75	50	.75	90	X		20,250	35,438

In other words, the area could support 198,000 user days of bathing if developed to the limit consistent with its OLI ratings. It is presently providing 126,000 potential user days which, when ownership and accessibility are considered, reduce to 47,250. Finally if institutional constraints, legal constraints and competing use are accounted for, the effective supply of the area is 34,438 user days of bathing.

Assumptions

(The assumption numbers correspond to those used in Table 1)

1. The area is in its natural state.
2. The area is in its natural state.
3. Area available - 100 linear feet of Class 1 and 200 linear feet of Class 2 bathing beach.
4. Space standards - with no development - Class 1 = 3 and Class 2 = 2 people/linear foot of beach - with Class 1 = 5 and Class 2 = 3 people/linear foot of beach.
5. Turnover rate is 2 people/day.
6. Season is 100 days with weather conditions preventing use 10 days/year.
7. 75 percent of the area in each Class is physically accessible.
8. 50 percent of the accessible area for each Class is open to the public.
9. Institutional factor ("K") is .75.
10. No legal constraints.
11. No competing land or water uses.

CORD STUDY TECHNICAL NOTE 3

THE DEFINITION AND EVALUATION OF A CLASS OF ALTERNATIVE-SITE FUNCTIONS

J. Beaman and S. Smith

ABSTRACT

The effect of the availability of alternative locations at which to participate in an activity has long been recognized as affecting participation at a given site. In fact, it has been recognized that either having a variety of alternatives around a person's origin or having a variety of destinations around a possible destination means that origin and destination alternative factors should be considered in modelling travel behaviour.

A number of desirable characteristics of alternative functions are discussed in this paper and it is indicated that the particular class of alternative functions being considered satisfies each condition under specific conditions. Ways are shown in which the approach to defining alternative factors has been unnecessarily ad hoc.

The paper presents results that demonstrate that the coefficients (exponents of distance) that some researchers have used in defining alternative factors mean that distant alternatives are more important in determining people's behaviour than facilities that are close. The range of value of exponents that result in close alternatives being more important to people's behaviour than distant alternative is defined.

PURPOSE

The purpose of this note is to discuss the formulation of, and the problems associated with, an alternative-site function.

BACKGROUND

The seminal work on the use of alternative sites in travel modelling is probably Stouffer's intervening opportunity model (see Reference 22). Stouffer argued that the reduction in the number of trips to increasingly distant destinations was not a reaction to distance costs, but rather a reflection of the successful competing for customers by nearer facilities over farther facilities.

More recently, Grubb and Goodwin (see Reference 10) developed a techique for operationalizing the concept of competing facilities as a component in recreation travel models. In their work on visitation to reservoirs distributed around Texas, Grubb and Goodwin formulated a general visitation equation:

(1) Y = A{X(1)**(b(1)) X(2)**(b(2)) X(3)**(b(3)) X(4)**(b(4))
X(5)**(b(5))}

WHERE

Y = the number of visitor days from origin i to reservoir j per unit of time;

X(1) = population of origin i;

X(2) = round trip travel costs between i and j;

X(3) = per capital income at i;

X(4) = surface area of j;

X(5) = a variable measuring the effect of competing reservoirs available to users at origin i on attendance at reservoir j, and

A,b(1),...,b(5) = parameters to be estimated.

In the context of this article the last variable, b(5), represents the major contribution of the Grubb and Goodwin study. Their competing-site or alternative-site function, to measure the impact of competition on reservoir j, was operationalized as:

(2) X(i) = @E (log S(k)/D(i,k))

WHERE

X(i) = alternative-site factor for origin i, reflecting the existence of alternatives to destination j;

S(k) = surface area of competing reservoir k;

D(i,k) = distance between i and k;

n = number of reservoirs within 100 miles (an arbitrary cut-off distance) of origin i; and and the summation is over n reservoirs.

The expected sign of X(5) in a least squares regression solution is negative. Thus, attendance at reservoir j can be expected to decrease as: (1) the number of alternative reservoirs (within 100 miles) increases; (2) the surface area of alternative reservoirs increases; and/or (3) the

distance to the alternative reservoirs decreases. Thus X(5) is intended to reflect the competition from all other available reservoirs.

A number of authors have furthered this investigation by introducing alternative-site factors into their recreation travel models. One of the most recently presented models that utilized such a factor is a day-use visitation model developed by Cheung (see TN 1). Other formulations which have been included in travel models were developed by Cesario, Goldstone and Knetsch (Reference 3), Pankey and Johnston (Reference 18) and Elsner (Reference 8). The effect of alternative sites has also been approached by examining them in a trade-off context. This approach considers the effect of alternative sites on the distribution of users among a system of competing facilities. A few relevant examples of this approach include the Ontario Tourism and Outdoor Recreation Plan Systems Model (Reference 24), Wennergren and Nielsen (Reference 27), Ullman and Volk (Reference 25) and Knetsch and Cesario (Reference 12).

THEORY

Figure 1 is used to present a simple graphic illustration of the alternative-site problem and some of the notations used in the following discussion of theoretical issues relating to the development of alternative-site functions. The volume of visitor flow from i to j is usually predicted on the basis of variables such as the population of i, the attractivity of j and the distance between them. A closer modelling of reality requires the inclusion of some measure of the competition of other facilities offering similar recreation experiences to the same user group. This is the purpose of introducing an alternative-site factor.

The omission of such a factor in, for example, the simple gravity model (which includes only measures of origin and destination characteristics, including distance, but not of alternative destinations) leads to the following logical, but unrealistic conclusion. Consider a simple unconstrained gravity model which predicts per capita use of a facility. If five more identical facilities are developed at the same distance from an origin, the gravity model implies that total per capita visitation at all sites will be six times as high as with one (i.e., it implies that demand is infinitely elastic with respect to supply). An alternative-site function embodies the more realistic assumption that total per capita visitation may increase, but not at the same rate as the proliferation of new facilities.

There is an exception to this scenario that deserves mentioning, especially in light of the very high usage some recreation facilities receive. If a facility is being used to capacity for some given activity, then the addition of one identical facility may result in a doubling in per capita visitation rates. This can be expected to occur whenever there is a latent demand for the services of a new facility. The solution to this apparent problem is the

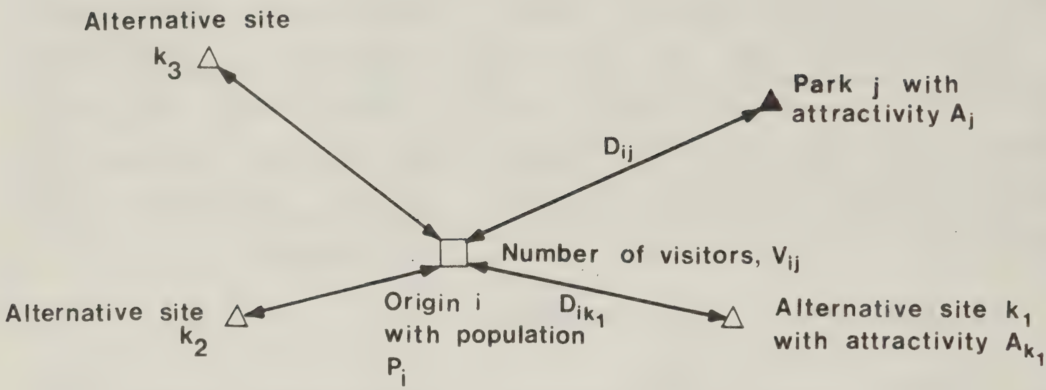
Alternative site
k_3
Park j with
attractivity A_j
D_{ij}
Number of visitors, V_{ij}
Alternative site
k_2
Origin i
with population
P_i
D_{ik_1}
Alternative site k_1
with attractivity A_{k_1}

Figure 1

recognition that if a facility is being used to capacity, a gravity model is inappropriate. In this situation of very high demand and very low supply, the appropriate use-level forecasting techniques should be based on capacity measures.

Another consideration is the fact that the reaction to alternative sites is largely a perceptual process. Consider now that a user at some origin is evaluating a large number of sites around him. It is quite feasible that, while he is able to distinguish among individual, nearby sites, he is unable to distinguish individual sites in a distant resort region. If he decides to go to this more distant region, his choice is based not on the sum of the attractions of the individual facilities in this region but rather on his perception of that region as a single "facility".

However, it is reasonable to suggest that once this user has arrived in that region and begins to make a choice between alternatives there, a second alternative-site function becomes important - a destination alternative-site function. This function is distinct from the initial alternative factor, which can be referred to as the origin alternative-site factor. The former is used to suggest, for example, that different stretches of a distant, developed beachfront compete with each other when (and only when) a user has arrived in the local area. Similarly, at home a user may decide among several National Parks, but once he arrives at his chosen park he has to decide among alternative campgrounds within that park.

It is possible to argue that this problem of perceiving at a distance differences between closely situated parks is solved by the attractivity factor included in the Grubb and Goodwin alternative factor formulation. However, the subsequent discussion shows that, in terms of the decision-making strategy outlined by the authors, the way a decision is made as to how one reacts either to comparable facilities competing with each other or to sub-units within a given park or beach, is best understood by considering both origin and destination alternative-site factors.

THE MATHEMATICS OF DEFINING AN ORIGIN OR DESTINATION ALTERNATIVE-SITE FACTOR: SOME GENERALITIES

While the authors have argued for a recognition of the possibility of a two-stage decision making process with regard to the ultimate choice of a recreation site, the general concepts and mathematics underlying each stage do not differ. It is possible to begin this section by offering three basic, important criteria against which any proposed alternative-site factor must be measured:

1. The competitive strength of any given alternative in an alternative-site function should be related to: (a) a measure of the attractiveness or utility of this alternative for a given usage; (b) the relative

accessibility of the alternative from the "origin" of visitors (either their home or an equivalent point on the highway);

2. The magnitude of the alternative-site function should reflect some aggregate of the individual alternatives; i.e. the competitive importance of the alternatives as a group is directly related to their total number;

3. Any alternative-site factor should reflect the addition or subtraction of a new destination area within the field of existing possibilities.

These criteria, however, are operationally imprecise and vague in that they do not state even the direction of relationships between the variables.

Within the contex of these general ideas, the aim of this paper is to describe how alternative factors should be defined (explicitly) so that irrational assumptions about the human decision-making process are avoided. The following mathematics are presented as a context in which to analyse the alternative-site factors suggested by some researchers. These mathematics can thus be used as an example of the kind of matters that must be explicitly considered in order to define an alternative-site factor in both a mathematically and behaviourally acceptable manner.

Consider the following function which is a generalized Grubb and Goodwin alternative-site function:

(3) X(i) = @E (A(k)/F(D(i,k)))

WHERE

X(i) = alternative-site function for some origin i;

A(k) = attractivity of alternative site k;

F(D(i,k)) = a function of the distance between i and k;

n = number of alternatives, and the summation is over n alternatives.

This equation suggests that an alternative-site function is defined by the sum of the ratios of attractivities of site to the distances of the sites from some origin. For an origin alternative-site factor, the origin is the visitor's residence, a city or the center of population of some region. In the case of a destination alternative-site factor the origin may be the point of arrival in the tourist region: an airport, the edge of town, a visitors' information office or the entrance to a park.

The attractivities that appear in the numerator can be measured in any of a number of ways, but current research in

Canada suggests that, at least for the purpose of main-destination visits to a site, attractivity measures are best estimated using the Cesario model (see TN 4). The distance function F(D(i,k)) is usually considered to be positively monotonic. This function can be based on several general measures: geographic distance, travel costs, travel time, or perceived accessibility. (For example, a visitor to an unfamiliar resort town may impute a smaller distance to a facility whose location is on the main street, a couple of miles from him, than to a closer facility whose address is on an unknown side street).

Equation 3 clearly satisfies the three criteria enumerated above. If, for example, a new site is included within the area of available alternatives, the alternative-site function increases in strength as the attractivity-distance ratio for the new site is added to those of the existing alternatives. Also, the more attractive a given alternative is, the more important it is in determining the value of the alternative-site function compared to other sites equidistant from the point of reference, either an origin or destination. This statement is, of course, based on the fact that if two sites enter into the formula and are at the same distance, the one with the larger attractivity has a larger ratio of attractivity to distance and therefore adds a greater amount to the alternative measure than the less attractive site. As for the relative accessibility of a given destination, the inclusion of a distance function in the denominator indicates that as an alternative destination gets further from a given origin, the alternative factor calculated is less influenced by this given destination.

As a final point, it is desirable to discuss one apparent limitation of the alternative-site function. Consider a region with two existing facilities serving one city, i, shown in Figure 2: In this scenario a planner is attempting to decide between two possible sites for a new facility - one fairly close to i (site B), the other more distant (site A) but otherwise identical to site B. In forecasting expected use levels, the planner uses Equation 3 as a measure of the effect of alternative sites on attendance at the new facility. Recalling the components of Equation 3, it is clear that the value of the alternative-site factor is the same regardless of whether Site A or Site B is chosen. Nevertheless attendance at B, ceteris paribus, would surely be higher than at A. Now, some planners may feel intuitively that this is at least in part a reflection of A experiencing greater competition from the intervening opportunities at sites 1 and 2, than would B, which is closer to i than sites 1 and 2. This view implies that an alternative k has a different effect on trip flows from i to a destination j, depending on whether D(i,j) is greater or less than D(i,k). This in fact is the basic assumption in Stouffer's intervening opportunities model, in which only places that are closer to origin i than j is, are included in the operational definition of intervening opportunities. All other sites are considered to have no competitive effect

on trips to j. It is to be argued below that this type of binary treatment of alternatives leads to conclusions logically inconsistent either with observed trip patterns or with the assumption of a uniform utility function which is implicit in Equation 1.

However, before pursuing that argument, a more sophisticated equivalent to Stouffer's definition of the alternative-site factor is considered. The United States Corps of Engineers (1972) suggested:

$$(4)\ X(i) = [1 + @E \log S(k)/D(i,k)]^2$$

$$\text{for all } \log S(k)/D(i,k) > \log S(j)/D(i,j),\ j \neq k=1,n$$

WHERE the variables are the same as defined for Equation 2.

There are three differences between Equation 4 and Equation 3. First, only those ratios of log S(k) to D(i,k) which are greater than the ratio of log S(j) to D(i,j) are included. In other words, if S(k)/D(i,k) is less than S(j)/D(i,j) then the alternative site k is not considered as an alternative at all. (It should be noted that one (1) is added to the restricted summation to prevent X from equalling zero, since the Corps of Engineers used 1/X(j) as a regressor in their estimating equation of reservoir use. Also the squaring of the quantity, one plus the summation, implies that the total effect of all substitutes increases at an increasing rate.)

The intuitive feeling that sites 1 and 2 constitute greater competition to site A than site B, reflects the assumption that the competitive strength of an alternative varies according to the relative location and attractiveness of the destination j being considered. The implications of this assumption are as follows. If it is argued that the volume of trip flows from origin i to j is unaffected by any site k whose A(k)/D(i,k) is less than A(j)/D(i,k), then in a behavioural sense, this implies that the population at i do not consider any site k to be an alternative to j if A(k)/D(i,k) is less than A(j)/D(i,k). The corollary of this is that there is no reason for any trips from i to j if there exists any alternative k such that A(k)/D(i,k) is greater than A(j)/D(i,k) since the latter, by the above assumption, does not constitute an alternative to and, therefore, competition for the former. In turn, and more fundamentally, this implies that for any origin i, one would expect all park users of the same type and with the same purpose to patronise the same park, since in all but very rare cases there is only one site which maximizes A(m)/D(i,m), m = 1, 2,..., n. Observation shows that all users of the same type and with the same purpose do(no(patronise the same site and therefore observation contradicts the above implication of deterministic choice behaviour. The only way to reconcile the deterministic behaviour implicit above with the reality of trip flows from i to more than one destination is to assume interpersonal differences in people's estimations of sites' attractivities

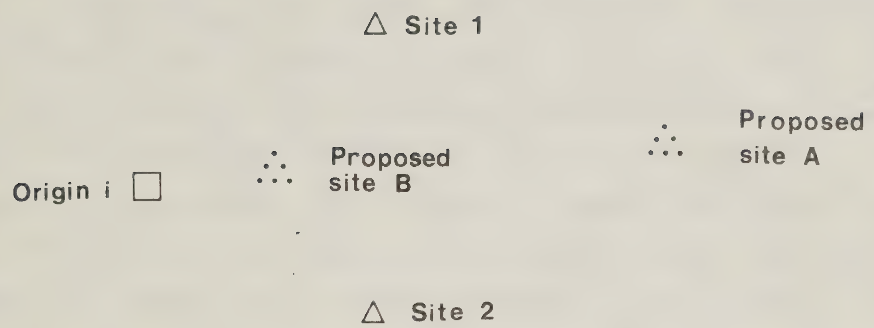

Figure 2

and/or distances, so that the site with the maximum $A(i)/D(i,j)$ will vary from person to person, and trip choices will vary accordingly. However, as presently written, Equations 2 through 4 do not allow for interpersonal differences in people's estimations of $A(j)$ and $D(i,j)$, $j = 1, 2, \ldots, n$. Thus Equation 4 and (by implication) the intervening opportunities model are internally inconsistent.

It might be argued by some that the idea expressed by the intervening opportunities model and Equation 4 is basically sound as a macro model. The values generated are expected values based on stochastic assumptions rather than deterministic predictions for individuals. An operational flaw still in these models, however, is that they give no weight to sites whose $D(i,k)$ or $A(k)/D(i,k)$ are less than $D(i,j)$ or $A(j)/D(i,j)$. This could be overcome by giving smaller, but positive, weight to alternatives with relatively low $D(i,k)$ or $A(k)/D(i,k)$. But this would require prior knowledge of the sites' attractivity values such as in Equation 4 where $S(k)$ is assumed to be a surrogate for $A(k)$. And this leads to a type of circular reasoning. For if $A(k)$ (an attractivity factor) is to be estimated using a model with an alternative-site function (such as a Cesario model), then the estimates of attractivity depend on a knowledge of the alternative weighting factors which, in turn, depend on the attractivity value.

Though some iterative procedure might eventually be devised to overcome this problem, it is questionable if such an effort is merited since there is no behavioural evidence to suggest that this (or any other form) of variable weighting of alternatives takes place in the human mind. Therefore, a simpler assumption is made in the following discussion. Specifically, alternative sites contribute to the alternative-site factor in direct proportion to the value of $A(k)/D(i,k)$ (or some similar function). The result is that a weight of unity can be applied to each term in the summation in Equation 3. In other words, the competitive strength of alternatives is assumed to be a quality intrinsic to them and not something which varies according to the destination being considered. Given this assumption, and returning to the hypothetical planning problem, the greater usage of site B than A can still be explained in terms of site B having intrinsically greater strength than site A against the competition from sites 1 and 2, on account of B's attractivity-distance ratio exceeding A's.

THE CHOICE OF A DISTANCE FUNCTION AND A SET OF FACILITIES TO BE CONSIDERED AS ALTERNATIVES TO A GIVEN FACILITY

Now that an alternative-site measure has been formulated, $X(i)$, which satisfies the criteria for such a measure, it is tempting to accept it and use it without considering further the behavioural implications of the

measure. However, it is a simple matter to show that the function has very different properties depending on the way F(D(i,k)) is defined. For example if:

(5) F(D(i,k)) = D(i,k)[a]

WHERE

D(i,k) = geographical distance between i and k, and

a = some exponent to be estimated.

then the value of the exponent has a profound effect on what X(i) suggests about the decision making process. There are, in fact, two considerations:

(1) how the universe of alternatives is defined (in areal terms),

(2) what distance function should be used.

And an important point to note is that the two issues cannot really be dealt with separately.

The question of the areal delimitation of the population of alternative sites was an issue in both the Grubb - Goodwin and the Cheung studies. Their arbitrary resolution was to define the population of alternative sites as that group of similar facilities located within 100 miles of the origin. Although arbitrary, Cheung did find empirical evidence that this radius was a reasonable one for planning purposes. He found that 90 percent of day-use visitors to a group of parks travelled less than 100 miles one-way to a park. From a relatively loose, practical viewpoint one can ignore the existence of distant parks; but from a more precise, theoretical viewpoint one can still acknowledge their influence, even if it is minimal, because of the visitor's reaction to distance.

Whether people consider alternatives only within a certain distance is related to a theoretical concern that has implications for defining alternative factors which are not pursued here. So the reader is asked to keep in mind that the arguments presented do not adequately deal with how people react to different distances. (See TN 14.) Early location and transportation models typically presented the view that "economic man" was hyper-sensitive. For example, consider two equally attractive parks, A and B. If A is located at 10 kilometers from a potential user, and B is 10.1 kilometers from this user, these models argued that A would always be chosen over B. A more realistic view of the perception of distance differentials is one that describes the rational man as being threshold-sensitive. In the case just presented, most users would not be sensitive to a margin of 0.1 kilometers. If, in a different situation, the facilities were located within a few hundred meters of the user, a marginal increase of 0.1 kilometers could be

significant. This threshold is referred to in psychology as the just-noticeable-difference (j.n.d.), and it has been shown in psychophysical experiments to be proportional to the magnitude of the stimulus, in this case distance. If distance is implicitly used to define the set of parks that serve as alternatives for another park (as it was used above) any number of distance functions may be considered relevant.

Figure 3 shows a hypothetical distribution of parks around an origin. Ten rings, equally spaced, surround an origin i. In the hinterland, covered by the rings, are a number of parks. For purposes of this discussion they have been uniformly spaced on a rectangular grid. The distance to any circle, j, from the origin, is DR(j) the distance to the next more distant circle from the center is DR(j+1). The distance between any two adjacent circles (the width of any ring) is "w" and this is constant. One unit of area has been sketched on the map and is sized so that it encompasses four parks. Thus the density of parks, "d", is four parks per unit area. If this square area unit has sides of one unit, application of the Pythagorean Theorem indicates that w, the width of the rings, is about 0.7 units. The outer circle encompasses the maximum distance that one is physically able to drive round-trip in one day, with just a minimal amount of time spent at a site. The extreme example would be the case where a user drives 110 kilometers per hour (about 70 mph) for 12 hours, hops out and back into his car in a second (thereby qualifying as a visitor) and drives home at 110 kilometers per hour for 12 hours. The outer ring, the physical limit for a day-use trip, is 110 km x 12 hours = 1320 kilometers. In nearly all real-life day-use instances, this physical limit is not even closely approximated. Its use, however, avoids drawing a smaller arbitrary boundary based on intuition or limited knowledge of past behaviour. The physical maximum also avoids the unrealistic and mathematically difficult situation of an infinite travel surface.

One of the first things that is noticed when one examines the figure is that the successive rings of equal width, moving away from the origin, include an increasing area. Given a uniform distribution of parks in space, as shown, the further one goes away from the origin the greater will be the number of sites included in a ring. The average number of parks per unit area is d, so the number of parks that may be expected to be found between any two circles is:

(6) N = area of ring * density of parks
      = {(2PI DR(j) + 2PI DR(j+1))/2}(w)(d)
WHERE PI = 3.1416...
AND since 2PI DR(j) approx = 2Pi DR(j+1)
IF w is small compared to DR(j),
THEN:

(7) N approx = 2PI DR(j)(w)(d)
      approx = 2PI DR(j+1)(w)(d)

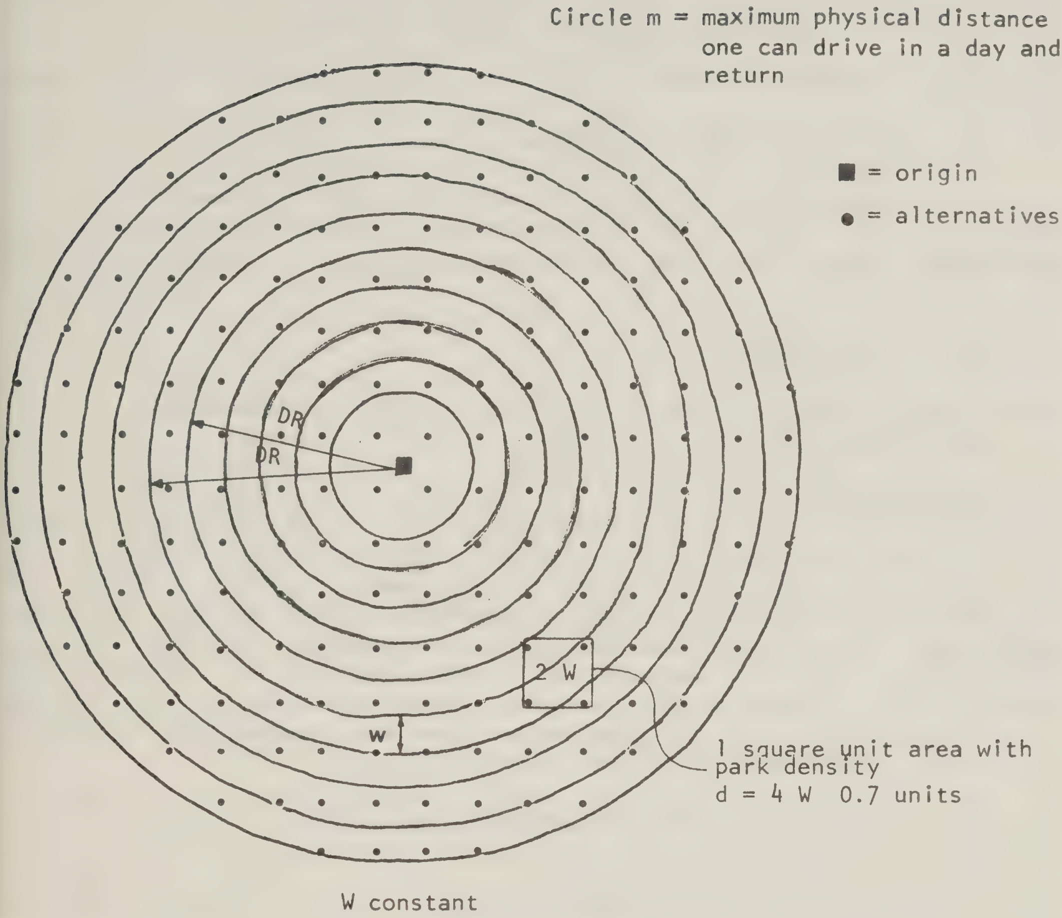

FIGURE 3

HYPOTHETICAL DISTRIBUTION OF DAY USE PARKS AROUND AN ORIGIN

WHERE N = expected number of parks in a ring;

DR(j) = radius of inner circle;

DR(j+1) = radius of next outer circle;

w = width of ring;

d = average park density.

If we assume all parks are equally attractive, the attractivity component in Equation 3 can be taken as a constant, AA, and the alternative-site function can be rewritten as:

(8) X(i) = AA @E (1/F(D(i,k))

WHERE AA = attractivity of alternatives; a constant, and the summation is over n alternatives.

If, however, we let DR(j) >> W, then the distance from the origin i to all the alternatives in the ring between j and j + 1 is approximately DR(j) approx = DR(j+1). In other words, if the ring width is sufficiently narrow, the distance to all parks in the ring is approximately equal to the distance to either the inner or the outer boundary of that ring. Hence DR(j) can be substituted for D(i,k) in Equation 8, where k is a park in the ring between circles j and j + 1. Using Equation 7 as an estimate of the number of parks in any ring, Equation 8 can be rewritten as:

(9) X(i) = AA @E 2PI DR(j)(w)(d)/F(DR(j))

WHERE m - 1 = number of inner circles; and the summation is over m-1 inner circles; and the other variables are as defined in Equation 3, 7, and 8.

Moving the constant terms outside the summation gives:

(10) X(i) = AA (2PI)(w)(d) @E DR(j)/F(DR(j))

WHERE the summation is over m-1 inner circles.

One question that was raised earlier, and remains unanswered is the choice of an appropriate distance function in the alternative-site function F(DR(j)) in Equation 10. The most common form of F(DR(j)) defines it as an exponential function, so that in the following section:

(11) X(i) = @E DR(j)/DR(j)**a

because F(DR(j)) = DR(j)**a

with the summation over m-1 inner circles.

Table 1 is a summary of the values of X(i) from Equation 10 for different values of a. To prepare the Table AA has been set to unity, w = 0.7 units, d = 4 parks per square unit and DR(j) ranges from 0.7 to 7.0 in increments of 0.7.

Examination of the cells in Table 1 permits one to draw behavioural inferences about each value of a. For those values below unity, the nearer parks contribute relatively little to the total strength of the alternative-site factor. For an a = 0, approximately 50 percent of the competition to some park comes from the large numbers of parks in outer zones 8, 9 and 10. Cheung suggested using an exponent of ! in his Saskatchewan day-use model. Table 1 indicates in this hypothetical case that, again, the nearer parks play a relatively small role in determining the total alternatives perceived at the origin. Specifically, less than 50 percent of the total day-use competition comes from the first six zones. Thus, if an exponent less than one is chosen for modelling purposes, the researcher has, explicitly or implicitly, stated that the total number of parks within the maximum physical driving range for day-use activity is more important than just the smaller number of closer, more accessible parks. For example, when a equals !, even though the attractivity-distance ratio is considerably greater for a park in (for example) ring 2 than in ring 10, so that a park in ring 2 has two to three times the chance of being chosen than one in ring 10, there are about seven times as many parks in ring 10 as in ring 2. As a result, there is a higher probability of zone 10 being visited more than zone 2.

An interesting consequence of this would be that a graph showing numbers of visitors (on the y-axis) against destination distance (on the x-axis) would have a positive slope. In the past, students of spatial interaction derived such curves and drew conclusions about the friction of distance from the slope. It bears emphasis that the slope of this curve is so biassed by the spatial distribution of alternatives, as is vividly shown in this example, that it is quite useless in estimating the friction of distance. In the present example the conclusion from the positive slope would be that distance had positive rather than negative effect on usage, even though Equation 11 indicates the opposite. Even so, some current research based on more sophisticated methods than the distance decay curve still ignores the biassing effect of the spatial distribution of alternatives on trip flow data.

A different inference can be drawn from the results when a is greater than unity. Distance and travel costs play much more important roles than previously, and can be considered more important than the increasing number of parks or distance in influencing the probable maximum distance a user will drive. The increase in the relative competitive advantage of nearer sites increases rapidly with higher a-values. For an a = 2, most of the competition in this example comes from the first three zones; for a = 3,

TABLE 1

SUMMARY OF THE EFFECTS
OF A CLASS OF ALTERNATIVE-SITE FUNCTIONS

Percent of Alternative-Site Function Value Attributable to Each Ring

	(inner)								(outer)		
a	1	2	3	4	5	6	7	8	9	10	X(i)
0	2	4	5	7	9	11	13	15	16	18	676.8
1/2	4	6	8	9	10	11	12	13	13	14	332.3
1	10	10	10	10	10	10	10	10	10	10	175.8
3/2	20	13	12	10	8	8	8	7	7	7	105.5
2	33	17	12	10	7	5	5	5	5	2	73.8
3	68	16	6	4	4	4	*	*	*	*	54.5
5	93	5	2	*	*	*	*	*	*	*	77.4

* Less than 1%

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most comes from the first zone; and for a = 5 nearly all comes from the very closest parks.

Further interpretation of the higher a-values suggests that they may be appropriate for, for example, the day-use activities of small children, the elderly, the handicapped and the otherwise immobile. Conversely, very low a-values would more logically apply to highly mobile individuals; and perhaps to a special class of day-users who may desire to visit several facilities in one day.

CONCLUSION

The point of the preceding discussion is that there are behavioural implications that need to be considered when making what may seem to be a strictly empirical decision. The use of an alternative-site function in a day-use model necessitates the researcher having an explicit awareness of his study population and activities. A recognition of the behavioural or human forces operating in a recreation system should be considered, and used to evaluate the implications of any given empirical solution. At the extreme, then, it is conceivable that a model with a high R^2 should be rejected for planning purposes because of possible misleading or nonsensical behavioural interpretations of the empirically elegant model.

MEASUREMENT OF SUPPLY USING NATIONAL INTERVIEW DATA ON PARTICIPATION IN OUTDOOR RECREATION ACTIVITIES

J. Beaman, S. Smith, and Y. Kim

ABSTRACT

A recurring theme in outdoor recreation research is the need to develop models to forecast future use levels for outdoor recreation facilities. However, most aggregate demand models describe how demand is related to socio-economic characteristics of populations. Consequently such models are calibrated from data on observed participation. Their weakness is that the "observed use levels" are not only a function of demand but also of supply.

This paper presents an approach to defining the effects of supply on the rate of participation in an activity. The effect of supply is measured by finding out the average errors in predictions of the participation in an activity that took place in given areas. It was expected that by using a model that did not take into account the distribution of supply there would, on the average, be over-predictions of the amount of participation in areas with "low supply" for an activity and vice versa for areas with a high level of supply. In other words residuals from a regression in which supply was not considered were expected to be significantly positive on the average in some areas and significantly negative in other areas.

Statistically very significant residuals were found and do appear to be associated with availability of supply. These were found using 1972 Secretary of State leisure time date for 25,500 independent individuals, people from different households.

One result of the study was to show that a significant effect of supply could not be determined from 1972 CORD Study National Survey data. Reasons for this result are discussed in a special appendix to the paper where sample size formulae and the accuracy of supply factors are discussed. It is concluded that to get results that are good enough to study how supply factors are determined by the supply on the ground 800,000 interviews would be necessary from 60 geographic areas. However, it is also indicated that a well designed analysis with interviews from a few areas (about 8) could be successful with only about 80,000 interviews.

PURPOSE

The purpose of this note is to present research work on the development of a quantitative, behaviour-based measure of the effects of supply of facilities for participation in some activity on participation in that activity.

INTRODUCTION

A central concern in planning for outdoor recreation involves the development of models to forecast future use levels for facilities that are built. Most forecasting models used in recreation research have been destination models based on demand factors describing socio-economic characteristics of target populations; cost (usually as distance); attractiveness or quality of existing and proposed sites; and occasionally measures of the numbers of alternative facilities. Such models are calibrated from observed participation figures (see Chapters I, II, III, VII and IX of this volume in which relevant notes are included). There have been origin models developed but in these it is almost invariably only socio-economic variables that are considered. However, a critical weakness of this approach is that the models developed do not reflect supply. They make participation only a function of demand factors. The 1969 study by Cicchetti, Seneca and Davidson is one of the rare cases where a "supply factor" has been incorporated into an analysis so that the level of supply does influence the amount of participation predicted.

The reason that other quantitative studies reported on in this volume such as those on the use of ANOVA and AID models (TN 12, TN 20) do not relate peoples, total behaviour to the amount of supply around them is not simple. A major problem is the problem encountered by Cicchetti, Seneca and Davidson. That was that information on supply which was at all adequate for use in a model was rarely available. The research reported on in TN 16 and the Facility Inventory, reported on in Volume III, show that CORD Study research has focused on how to inventory supply that is on the ground. The lack of success of the Canadian Outdoor Recreation Demand Study Facility Inventory (as reported on in Volume III) meant that inventory data were not available for building the kind of model proposed by Cicchetti, Seneca and Davidson, and suggested by Knetsch for the CORD Study demand analysis (see Chapter I).

In the way of introduction one final point seems important. A traditional approach to modelling supply effects on participation has been to intuitively decide on some physical resource as a limiting factor for participation in a given activity at a given location. For example, one may choose as a measure of "camping supply" the number of campsites in a ring around a population centre, divided by their distance from that center, summed over a number of concentric rings. This number can then be used in

a model to adjust for probable expansion or contraction of supply. A concern raised by this approach, however, is just why one measure of supply is used rather than another one. In modelling it is frequently difficult to say, a priori, which model is better among a multitude of alternatives. A researcher may even be able to decide which class of models is more appropriate from a behavioural point of view, but he still has to choose between many possible permutations of a given model. An empiricist may not share this problem of choosing the "best" model since his decision can be made on a straightforward and objective basis--the best model is the one which most closely fits observed data. This choice-making tactic has a major weakness for planning purposes--the model chosen on an empirical basis is not necessarily generalizable to other situations of recreation supply-demand systems. This difficulty of deciding on a most appropriate model is also discussed for related topics in TN 3, 12, 19, 20, 27, 30 and 35.

The supply factor computation described in this paper has the desirable quality of avoiding the difficulty of having to select among several formulations. Further, once a supply factor is obtained it may be possible to explain this empirically derived factor by using conventional supply measure formulae. For those regions in which there is evidence of supply effects on participation it may be possible to examine the levels of facility and resource development logically or intuitively associated with those activities exhibiting possible supply effects. Ideally this analysis would lead to the further identification of what natural and man-made resources (in terms of quantity, quality, location, costs, advertising, management policies and so on) define supply for a given activity.

HISTORY OF THE PRESENT WORK OF DEVELOPING A MEASURE OF SUPPLY ON PARTICIPATION: INTRODUCTION TO THE METHODOLOGY

Work on a version of this paper began in 1973. This work began using 1972 National Survey information broken down so that observations were associated with 75 different geographical areas in Canada (on these data and geographic codings on these data see Volume III). As work on various Canadian Outdoor Recreation Demand Study projects proceeded, it became clear that considerations of the way that people reacted to alternative facilities made it important to derive a measure of how people perceived supply. It was recognized that this should not be some ad hoc formulation that a researcher dreamed up such as the following supply measure for an origin area for some activity

(1) Supply Measure = @E {(attractiveness of a site)**A/
(distance from the origin to the site)**B}
WHERE the sum is over all of an origin's sites for a given activity.

The general kind of supply measure just defined is called an alternative factor elsewhere (TN 1, TN 3) and used in other ways in other research (TN 5, TN 11). Regardless it suggests that a person perceives the amount of supply based on how far it is from him and how attractive it is. The issue of concern here is: "Is the function that was chosen correct?" An approach that may ultimately lead to an answer is not to start with a function but to start with assumptions and proceed to derive values which reflect peoples, response to supply. Having such values or supply measures for each of a number of geographic locations allows one to work backwards to find the function that explains the measures in terms of what is on the ground (see TN 4 for Cesario's approach to explaining attractiveness values).

The conceptual strategy adopted was to measure the effects of supply in several steps:

(1) Assume that supply was homogeneously distributed in all regions in Canada;
(2) Use an existing model (such as the one reported on in TN 12) to make estimates of the amount of participation in some activity in each of these regions;
(3) Obtain actual participation levels and compare these to the predictions;
(4) Examine the differences between actual and predicted participation figures to see if this difference shows that there is a statistically significant difference between observation and predictions that may reasonably be accounted for by the level of supply in the different geographical areas considered.

The kind of supply factor being described can be defined as follows:

SF(i) = Supply factor area i
= @E (observation - predictions)/N(i)

WHERE the sum is over all persons from i for whom there are data in the survey used and N(i) is the total number of such people in i.

Given the assumptions just cited a negative sum of residuals and thus a negative average value of the residuals could be expected for a region when observed use levels are less than the predicted. Because this average is negative even taking into account the socio-economic factors it is reasonable to refer to this average value of residuals as a supply factor for the given region for the activity considered subject to some qualifications introduced subsequently. If an area has abundance facilities for the activity considered, if it exceeds a national average and these are being used, it may be expected that observed participation will exceed the national average and in this case the average value of a residual will be positive. So, the supply factor defined by the average value of residuals

for the geographic area will be positive.

There are some points of criticism that can be raised about the rather naive formulation just introduced, but these are only raised in the discussion section of the paper. Now further background on the actual estimation attempts that were carried out in an effort to obtain supply measures and to verify that these were statistically significant is introduced. This is because there has been a history of problems in developing what may already sound to the reader as a very simple measure of how people respond to supply.

Initially, when predictions were made about peoples, behaviour in various outdoor activities both using the model indicated in TN 12 and using a model generated by the Michigan AID program (see TN 20) the supply effects determined were highly variable. This was true even though they were based on interview information from 4,000 people, and was true both in trying to explain participation and non-participation and in trying to explain the amount of participation. The reason that the amount of participation was finally disregarded in the analysis is that it is known that in Canadian Outdoor Recreation Demand Study National Survey data people's reported volume of participation (1) may reflect enthusiasm for an activity which destroys the relationship between the total volume of supply in an area and participation; (2) the amount of participation reported is known to be very unreliable and (3) it seemed more plausible when this research was being carried out to assess the amount of supply perceived to be available by assessing general perceptions of this supply than to let the analysis be dominated by a fairly high level of participation by some people in some geographic areas whereas in other geographic areas there may be a quite general but lower level of participation by the people.

Regardless, the initial analysis attempt involved developing both frequency of participation based supply measures and participation or non-participation based supply measures. The results produced were disappointing. After much computer programming and sorting out of residuals for a large number of activities, it was concluded that significant supply factors had been estimated. However, these supply factors had been estimated on the assumption that the CORD Study National Survey information resulted from interviews in 4,000 different households to get the information on 4,000 different individuals. Subsequent checking of this matter showed that the commercial company that carried out the interviews, interviewed more than one person in a large number of residences. This introduced a correlation between participation figures that resulted in a significant relation between supply and participation becoming an insignificant relationship. Many hours of work carrying out rather sophisticated statistical tests to show a result significant at the 5% level was simply lost!

The only option that offered any promise for measuring the effect of supply on participation was to use a data set

in which the kind of intercorrelation just cited did not occur, ideally a data set which was much larger so that there would be a much better chance of observing a supply effect. One problem with 4,000 observations and 75 geographic areas was that there is not much information about each area and consequently the variation of each supply factor tends to be large in comparison to anything that is to be explained (see the Appendix).

Fortunately in 1972, data were collected by Secretary of State, Citizenship Branch, on participation in leisure activities. These data included information on participation in some outdoor activities and thus these data offered good potential for analysis. Unfortunately, the 52,000 interviews carried out in this study were not carried out in different residences but it was possible to select about 25,000 interviews from the Secretary of State data set on the basis of a random selection of single interviews out of households. This gave a reduced tape on which all of the interviews could be considered to be independent. So after supply factor research work had continued for over two years a new data set was adopted.

These data from the Secretary of State tape which were actually used in the analysis are indicated in Figures 1 and 2. The sixty-two geographic areas used are relatively homogeneous economic areas of the different Canadian provinces as defined by Statistics Canada for the 1972 Labour Force Survey.

Now, one final point before proceeding to presenting results. As research work on this project went ahead, it was recognized that estimation need not always be carried out by producing residuals and using a special program to process these in a number of steps. The reader who is familiar with the theory behind least squares estimation will know that if one sets up a model such as the one indicated by the equation following then he can estimate the coefficients in the model by simply using a regression analysis program:

Probability of person in region r with given socio-economic characteristics participating	=	M + socio-economic effects + region r supply effects + error

WHERE (M + . . .) is as defined in TN 12.

The regional supply effect is the regression coefficient that "explains" how, on the average, the region differs from an average region after correcting for socio-economic effects.

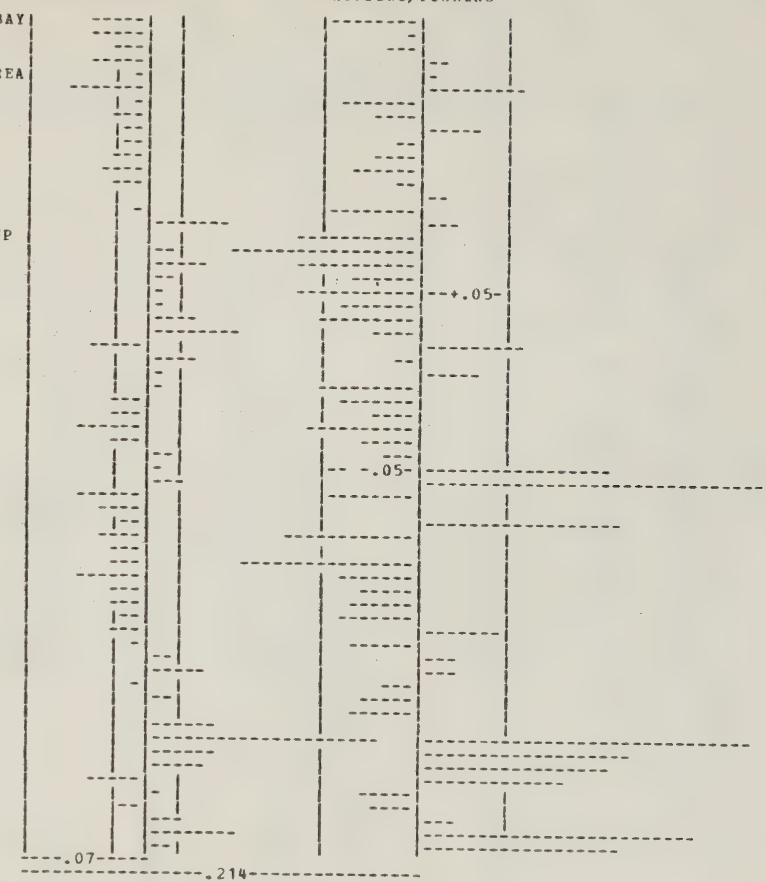
In actually carrying out computations to determine if the supply factors indicated in the equation shown above were significant, first a regression was carried out in which no supply factors were included. This allows one to

FIGURE 1

SUPPLY FACTORS* PLOTTED FOR THE ORIGINS TO WHICH THEY APPLY

SNOW SKIING HUNTING/FISHING

00 SOUTH CENTRAL AREA FROM CAPE RAY TO PLACENTA BAY
01 ST. JOHN'S
02 AREA BETWEEN TRINITY BAY AND BONAVISTA BAY
03 BISHOPS FALLS AND SURROUNDING AREA
04 ST. GEORGES BAY TO WHITE BAY-SW TO NCENTRAL AREA
05 GOOSE BAY AND NORTHERN NFDLD.
10 PRINCE EDWARD ISLAND
20 CAPE BRETON ISLAND
21 EASTERN NOVA SCOTIA-N TO AMHERST,W TO TRURO
22 HALIFAX
23 NORTHERN SHORE ON BAY OF FUNDY AREA
30 MONCTON AND SURROUNDING AREA
31 SAINT JOHN
32 FREDERICTON AND SURROUNDING AREA
33 NEWCASTLE AND SURROUNDING AREA
40 NORTHERN AND EXTREME EASTERN QUEBEC
41 AREA SOUTH OF ST. LAWRENCE FROM LA POCATIERE UP
42 QUEBEC-LEVIS AREA
43 AREA NORTH OF QUEBEC-TROIS-RIVIERES
44 NORTH OF MONTREAL-ST. JOVIETE,ST. GABRIELLE
45 SOUTH OF MONTREAL-GRANBY, SHERBROOKE
46 IMMEDIATE AREA SURROUNDING MONTREAL
47 MONTREAL
48 HULL-GATINEAU AREA - MANIWAKI
49 EASTERN QUEBEC-TEMISCAMING UP TO JAMES BAY
50 OTTAWA AND SURROUNDING AREA
51 KINGSTON - PETERBOROUGH AREA
52 TORONTO
53 HAMILTON
54 LONDON AREA
55 WINDSOR AREA
56 KITCHENER AREA
57 AREA SURROUNDING GEORGIAN BAY
58 N. EASTERN ONTARIO
59 WESTERN ONTARIO - THUNDER BAY
60 WINNIPEG
61 AREA IMMEDIATELY EAST OF WINNIPEG
62 AREA IMMEDIATELY NORTH OF WINNIPEG
63 AREA IMMEDIATELY WEST OF WINNIPEG
64 WESTERN MANITOBA UP TO RUSSELL-BRANDON AREA
65 WINNIPEGOSIS AND SURROUNDING AREA
70 REGINA
71 SOUTHWEST SASKATCHEWAN - MOOSE JAW
72 SASKATOON
73 AREA NORTH OF REGINA - CANORA
74 PRINCE ALBERT AND SURROUNDING AREA
80 SOUTH EAST ALBERTA-MEDICINE HAT AREA
81 SOUTH CENTRAL ALBERTA-LETHBRIDGE GALT AREA
82 CALGARY
83 AREA ONE HUNDRED MILES EAST OF EDMONTON
84 EDMONTON
85 AREA N OF N SASKATCHEWAN R AND EDMONTON
86 ALBERTA PEACE R REGION-NORTHWEST ALBERTA
90 SOUTH EAST CORNER OF BRITISH COLUMBIA
91 S.E. B.C TRAIL-ROSSLAND AREA (OKANAGAN AREA)
92 KELOWNA
93 SOUTH CENTRAL B.C. KAMLOOPS AREA
94 VANCOUVER
95 VANCOUVER ISLAND.VICTORIA NANAIMO AREA
96 PRINCE RUPERT AREA
97 NORTH CENTRAL B.C. - PRINCE GEORGE AREA
98 NORTH EASTERN BRITISH COLUMBIA



* The scales on which the snow skiing and hunting and/or fishing supply factors are plotted differ slightly. For snow skiing, there is about .0017 units per mm.; for hunting and/or fishing, there is about .0015 units per mm. This difference occurs because of the way that the computer program used scale results. Given the slight discrepancy between the scales and the fact that the supply factors should not be compared, no common scale was established even though both plots were related to a common baseline.

FIGURE 2

SECRETARY OF STATE DATA VARIABLES AND THEIR LEVELS
AS USED IN DERIVING SUPPLY FACTORS

VARIABLES		LEVELS OF VARIABLES	
IDENTIFICATION	DESCRIPTION	IDENTIFICATION	DESCRIPTION
VAR005	Population of Sampling Area	1	Under 20,000
		2	20,000-49,999
		3	50,000-99,999
		4	100,000 and Over
VAR006	Gender of Respondent	1	Female
		2	Male
VAR007	Age of Respondent	1	Under 16
		2	17-24
		3	25-44
		4	45 and Over
VAR059	Marital Status	1	Single
		2	Married
		3	Other
VAR060	Relation to the Head of Household	1	Spouse
		2	Son of Daughter
		3	Relative, Boarder, Employee, Other
		4	Head
Household*	Number of Individuals In Household Interviewed	1	1
		2	2
		3	3 or 4
		4	5 and Over
ORIGIN	Origin of Respondent	1-62	For description see Figure 2
FISHING/HUNTING	Participation in Fishing and or Hunting	0	Non participant
		1	Participant
SNOWSKIING	Participation in Snowskiing	0	Non participant
		1	Participant

*Note: This variable was not on the original tape. It was generaled by a program that selected 1 individual from each household and at the same time counted the number of individuals interviewed in the household.

TABLE 1

SOCIO-ECONOMIC EFFECTS B(i,j), BY ANOVA AND SUMS OF SQUARES EXPLAINED BY AID AND ANOVA

		SNOW SKIING							HUNTING AND FISHING						
		ANOVA Model with socio-economic effects		ANOVA Model with socio-economic and origin effects		AID socio-economic analysis	Unweighted ANOVA Model with socio-economic effects		Unweighted ANOVA Model with socio economic and origin effects		Weighted ANOVA Model with socio-economic effects		Weighted ANOVA Model with socio-economic and origin effects		AID socio-economic analysis
Variable	Level	Beta	St Dev	Beta	St Dev		Beta	St Dev	Beta	St Dev	Beta	St Dev	Beta	St Dev	
VAR005	1	-.01783	.00289	-.01604	.00330	See Table 2 for AID results	.02493	.00504	.01669	.00436	.01074	.00574	.00965	.00435	See Table 2 for AID results
VAR005	2	.00092	.00519	.00008	.00587		-.00165	.00906	-.00857	.00723	-.01677	.01020	-.01225	.00731	
VAR005	3	-.00487	.00581	-.00130	.00634		.00973	.01013	.00179	.00861	.01189	.01102	-.00029	.00797	
VAR005	4	.02178	.00300	.01726	.00395		-.03302	.00523	-.00991	.00406	-.00586	.00687	.00290	.00492	
VAR006	1	-.00766	.00227	-.00759	.00226		-.12065	.00395	-.11499	.00374	-.12007	.00393	-.10929	.00375	
VAR006	2	.00766	.00227	.00759	.00226		.12065	.00395	.11499	.00374	,12007	.00393	.10929	.00375	
VAR007	1	.02881	.00559	.02884	.00557		.06577	.00975	.04255	.00930	.06939	.00967	.03363	.00865	
VAR007	2	.01986	.00312	.01951	.00311		.02608	.00544	.01865	.00548	.02559	.00540	.01439	.00501	
VAR007	3	-.00080	.00310	-.00224	.00309		-.00364	.00540	-.00127	.00519	.00082	.00537	.00260	.00489	
VAR007	4	-.04768	.00324	-.04610	.00323		-.08821	.00564	-.05992	.00487	-.08580	.00561	-.05008	.00473	
VAR059	1	.03727	.00379	.03573	.00377		-.01380	.00660	-.01362	.00435	-.01193	.00655	-.00941	.00434	
VAR059	2	-.01860	.00374	-.01762	.00373		.01648	.00653	.02260	.00547	.01543	.00648	.02022	.00545	
VAR059	3	-.01867	.00384	.01811	.00382		-.00267	.00670	-.00898	.00404	-.00350	.00664	-.01080	00406	
VAR060	1	.01409	.00502	.01264	.00500		.02386	.00875	.01110	.00678	.02039	.00869	.00919	.00663	
VAR060	2	-.00846	.00559	-.00735	.00557		-.03110	,00975	-.01763	.00741	.02655	.00967	-.01665	.00700	
VAR060	3	-.00786	.00531	.00632	.00529		-.00430	.00926	.00642	.00559	-.00462	.00919	.00414	.00559	
VAR060	4	.00224	.00416	.00103	.00404		.01154	.00708	.00010	.00505	.01078	.00703	.00333	00500	
HSHLD	1	.00783	.00443	.00889	.00443		.00549	.00773	.00619	.00510	.00058	.00770	.00303	.00511	
HSHLD	2	.00001	.00263	-.00076	.00263		.00953	.00459	.00791	.00334	.00905	.00456	.00580	.00421	
HSHLD	3	.00372	.00282	.00367	.00281		-.00203	.00493	-.00615	.00561	-.00148	.00489	-.00276	.00342	
HSHLD	4	-.01156	.00450	-.01181	.00452		-.01299	.00785	-.00796	.00558	-.00814	.00785	-.00607	.00535	
General Mean		.06996 (Y .05344)		.07145 (Y .5344)	Y .05344	$\bar{Y}$ = .05344	.22033 (Y .2079)		.2135 (Y .2079)		.24206 (Y .2079)		.22848 (Y .2079)		Y = .2079
Total Sum of Squares			1279.74		1279.74			4265.07		33428.4		4165.07		36018.8	
Explained Sum of Squares			51.7374	69.83				428.72		3778.90		510.40		4259.16	
R Squared			.04043		.0546			.1005		.113		.1225		.1182	
Residual Sum of Squares			1228.00		1209.91			3736.36		29649.5		3654.68		31759.7	
Residual Degrees of Freedom			25280		25219			25280		25280		25219		25219	
Regression Degrees of Freedom			15		76			15		15		76		76	
F Statistics			71.005		19.153			193.378		214.799		46.342		44.5	
Standard Error of Residual			.220		.219			.384		1.083		.381		1.122	

Note: These results are based on 25,296 cases selected from data reported on in 'A Leisure Study, Canada 1972' by Carol Kirsh, Brian Dixon and Michael Bond. The report was produced for the Department of the Secretary of State, Canada.

determine the variance explained when supply is considered not to be important. It also allow one to know how much variance remains to be explained. Then, when 62 additional parameters were introduced, the 62 geographic areas (indicated in Figure 1) were considered and supply factors computed for them. To assess statistical significance of these supply factors, one need only ask whether the introduction of these parameters has resulted in more variance being explained than would be expected to be explained by chance (for a similar test see TN 27). In this particular case the introduction of the supply factors as indicated subsequently should have explained less than 5 thousandths of the variance that remained to be explained after socio-economic factors were considered. Yet far more variance than this was explained.

To be very specific the regression analyses were carried out as described because it was more convenient to carry out regressions, with only socio-economic variables and with both socio-economic variables and supply effects than to follow the more complicated analysis procedure described subsequently for the AID analysis. This is because with one run of the regression program made with a few control cards results were generated.

However, one caution is appropriate at this point. The procedure just outlined is perfectly adequate for determining if there are significant supply effects. But, there is the remote possibility that the supply factors computed may have variance in common with the socio-economic effects which are included in the model. If one wanted to get supply factors that were absolutely not "polluted" by socio-economic effects, it would be necessary to make a first regression run and produce the residuals from this regression run. Then the supply factor would be computed directly from the residuals (by a regression or some less costly procedure). The point is that when a regression is carried out and then the residuals are subjected to further analysis, the variance that is found in the residuals is variance which is not in common with the variance that has previously been explained by the socio-economic variables used in the original regression. This occurs because as is well known for least-squares estimation, the residuals are uncorrelated with, or in other words, orthogonal to the parameter space. Regardless, examination of Table 2 shown clearly that whether or not supply factor effects were computed the socio-economic effects had roughly the same value, e.g. in row 1, one sees that the effects for snow skiing of being at level 1 of variable 59 are .0178 and -.0160 which differ by less than .003, which is the standard duration for both coefficients.

If one carries out an analysis of the relation between socio-economic variables and participation using the Michigan AID program, when the AID program has been used and the residuals from the AID analysis have been written out on magnetic tape, one need only carry out an analysis of the residuals based on the following equation to see if

significant supply factors can be estimated:

Residual for a person = (regional supply effect for r)
in a region r + error

$$= SF(i) + e$$

In actual fact when AID was used in estimating supply effects and the residual differences between observations and predictions were written on magnetic tape so that these could be analysed using the regression program it was realized that the regression program need not be used. Because only 1 supply effect applied to each individual and the residuals already had a mean of zero overall a special purpose "regression program" was written which calculated the supply factors, presented in Table 3. This program took advantage of the fact that each supply factor was only a weighted sum of residuals. Once the "residual tape" which had region as an identifier was sorted by region observations were read one after the other with supply factors being produced as sub totals and total sums of squares explained being accumulated throughout the run. The supply factors program was also used to compute sums of squares explained and sums squares that could not be explained by supply factors (see Tables 1, 2, and 3). It then became possible as described before to compare the sums of squares explained with those that could be expected to be explained by chance.

TABLE 2

SUMMARY RESULTS ON AID ANALYSES

SNOW SKIING			HUNTING AND FISHING		
Group	No. of People in the group	Mean for the group	Group	No. of people in the group	Mean for the group
20	411	0.241	16	27	0.556
21	1019	0.184	28	11	0.545
6	178	0.174	20	335	0.540
2	513	0.140	21	2023	0.453
16	355	0.130	15	2008	0.388
15	1077	0.103	18	2167	0.315
26	544	0.096	29	2455	0.285
23	1976	0.088	19	826	0.276
27	2253	0.073	9	1565	0.235
24	680	0.063	23	400	0.213
9	558	0.045	7	367	0.166
28	4121	0.043	26	3740	0.149
19	1259	0.021	24	5995	0.088
11	10190	0.014	27	1088	0.070
29	162	0.012	25	2289	0.033

TABLE 3

ESTIMATED SUPPLY FACTORS (SF)

SNOW SKIING, SF's & then SD's

	From ANOVA		Based on AID Residuals				From ANOVA				Based on AID Residuals			
	Unweighted		Unweighted		Weighted		Unweighted		Weighted		Unweighted		Weighted	
Origin	SF	SD	SF	SD	SF	SD	SF	SD	SF	SD	SF	SD	SF	SD
1	-.034	.016	-.036	.016	-.023	.012	-.014	.028	-.046	.028	-.006	.028	-.029	.025
2	-.036	.010	-.034	.011	-.012	.007	.013	.017	-.003	.018	.037	.016	.015	.013
3	-.019	.018	-.012	.015	-.008	.012	-.029	.031	-.021	.028	-.018	.033	.000	.028
4	-.037	.014	-.038	.014	-.024	.011	.028	.025	.013	.030	.038	.023	.013	.021
5	-.011	.014	-.008	.013	-.005	.010	.028	.025	.004	.028	.030	.022	.000	.021
6	-.055	.048	-.048	.051	-.039	.045	.063	.084	.059	.113	.059	.084	.023	.081
7	-.007	.012	-.007	.011	-.007	.008	-.027	.022	-.043	.019	-.023	.023	-.017	.019
8	-.024	.012	-.023	.011	-.010	.008	-.003	.021	-.022	.019	-.013	.022	-.016	.018
9	-.013	.010	-.012	.008	-.009	.006	.052	.017	.037	.026	.070	.014	.052	.012
10	-.015	.007	-.016	.006	-.009	.005	.004	.012	-.014	.013	.015	.011	.006	.010
11	-.016	.012	-.016	.010	-.011	.008	-.009	.021	-.026	.021	.002	.021	-.004	.018
12	-.026	.012	-.023	.011	-.017	.008	-.046	.021	-.044	.015	-.030	.022	-.015	.018
13	-.017	.010	-.017	.010	-.012	.007	.007	.017	-.017	.018	.037	.015	.010	.013
14	-.002	.010	-.003	.009	-.004	.007	.003	.018	.014	.021	.037	.017	.015	.014
15	-.009	.014	-.006	.013	-.001	.010	-.067	.024	-.050	.018	-.059	.029	-.029	.024
16	.047	.015	.047	.014	.008	.001	.024	.026	.019	.029	.023	.026	.021	.022
17	-.002	.014	-.003	.013	-.005	.010	-.087	.024	-.072	.014	-.079	.028	-.063	.024
18	.012	.013	.012	.013	-.005	.010	-.018	.026	-.102	.012	-.170	.036	-.102	.029
19	.034	.009	.034	.009	.014	.006	-.009	.016	-.068	.009	-.062	.017	-.045	.014
20	.015	.012	.014	.011	.001	.009	-.069	.021	-.038	.015	-.065	.025	-.043	.021
21	.010	.011	.008	.010	.012	.007	-.107	.018	-.066	.106	-.107	.023	-.067	.018
22	.001	.010	.010	.009	-.003	.007	-.109	.018	-.043	.001	-.101	.022	-.059	.018
23	.029	.006	.026	.005	.019	.004	-.102	.011	-.058	.008	-.056	.009	-.030	.007
24	.057	.017	.058	.016	.015	.012	-.004	.029	-.022	.030	.024	.029	.027	.025
25	-.037	.033	-.037	.022	-.021	.017	.055	.038	.060	.049	.064	.038	.067	.032
26	.031	.008	.029	.008	.025	.005	-.009	.014	-.011	.014	.023	.013	.018	.011
27	.007	.011	.007	.009	.001	.007	.034	.019	.032	.021	.026	.017	.035	.014

28	.003	.006	.005	.005	.008	.004	-.006	.011	-.054	.008	-.002	.008	-.018	.007
29	-.021	.009	-.016	.008	-.002	.006	-.030	.015	-.042	.012	.001	.014	-.010	.011
30	-.017	.010	-.015	.010	-.006	.007	-.020	.017	-.027	.014	-.001	.017	.013	.014
31	-.039	.011	-.136	.011	-.018	.008	-.064	.019	-.016	.012	-.040	.020	-.027	.016
32	-.020	.010	-.017	.010	-.014	.007	-.077	.018	-.034	.011	-.046	.020	-.023	.015
33	-.011	.012	-.010	.010	-.007	.008	-.043	.020	-.109	.016	-.033	.023	-.013	.019
34	.006	.011	.008	.010	.005	.007	.110	.019	.105	.025	.122	.014	.092	.013
35	.027	.015	.023	.013	.008	.010	.204	.026	.198	.036	.227	.012	.177	.013
36	-.044	.009	-.042	.009	-.013	.006	-.057	.015	-.051	.010	-.013	.013	-.013	.010
37	-.029	.015	-.031	.015	-.014	.011	.020	.027	.000	.030	.031	.025	.010	.021
38	-.015	.033	-.015	.030	.001	.022	.017	.057	.114	.064	.031	.058	.019	.054
39	-.027	.020	-.029	.018	-.018	.014	-.064	.034	-.081	.002	-.044	.037	-.055	.030
40	-.024	.013	-.026	.012	-.019	.009	-.019	.022	-.003	.025	.030	.022	.019	.019
41	-.023	.023	-.025	.020	-.020	.016	-.077	.040	-.098	.023	-.062	.042	-.068	.036
42	-.046	.011	-.046	.012	-.020	.008	-.013	.019	-.044	.017	.016	.017	-.001	.015
43	-.027	.013	-.022	.012	-.016	.009	-.009	.023	-.031	.022	-.006	.024	-.018	.020
44	-.030	.013	-.030	.013	-.020	.009	-.026	.022	-.037	.017	-.003	.022	-.004	.018
45	-.017	.014	-.018	.012	-.016	.009	-.025	.025	-.049	.022	-.011	.026	-.021	.022
46	-.020	.011	-.022	.009	-.014	.007	.050	.019	.042	.024	.059	.018	.062	.016
47	-.003	.028	-.004	.024	.007	.018	-.014	.018	-.034	.040	-.017	.051	-.026	.041
48	.018	.014	.022	.012	.017	.010	.032	.025	.022	.029	.038	.024	.022	.021
49	.039	.009	.039	.008	.005	.006	.032	.015	.020	.017	.075	.012	.054	.010
50	-.005	.015	-.005	.012	-.010	.010	-.020	.026	-.022	.025	-.005	.026	-.000	.023
51	.016	.008	.014	.008	.012	.005	-.039	.014	-.034	.011	.001	.013	.004	.011
52	.001	.019	-.001	.018	.000	.013	-.018	.033	-.140	.033	-.007	.036	-.015	.030
53	.047	.016	.047	.014	.048	.011	-.046	.027	.035	.034	.053	.025	.026	.023
54	.233	.028	.222	.012	.013	.014	.195	.059	.192	.070	.205	.027	.122	.029
55	.044	.017	.044	.014	.008	.011	.122	.029	.118	.040	.132	.023	.102	.022
56	.038	.016	.037	.013	.020	.010	.121	.027	.113	.036	.131	.021	.094	.019
57	.036	.022	-.035	.019	-.021	.015	.056	.038	.079	.047	.070	.038	.092	.031
58	.003	.007	.004	.006	.002	.004	-.045	.011	-.028	.009	-.004	.010	.000	.008
59	-.017	.010	-.017	.009	-.012	.007	-.008	.017	-.025	.015	.015	.016	.010	.013
60	.021	.050	.019	.043	-.011	.037	.064	.094	.025	.113	.061	.086	-.002	.069
61	.061	.019	.061	.015	.033	.012	.155	.030	.158	.042	.154	.024	.120	.022
62	.011	.034	.012	.028	-.004	.023	.092	.059	.155	.078	.100	.059	.159	.049

TABLE 4

CORRELATION COEFFICIENTS BETWEEN AID AND ANOVA BASED SUPPLY FACTOR ESTIMATES AND AVERAGE (RMS) SIZE OF SUPPLY FACTORS[1]

SNOW SKIING RESULTS[3]

	Average size of Supply Factor (SF)[2]	CORRELATIONS ANOVA SF's	AID SF's unweighted	AID SF's weighted
ANOVA SF's	.0393 (.018)	1.0	.99 (.98)	.93 (.99)
AID SF's unweighted	.0390 (.016)	.99 (.98)	1.0	.93 (.99)
AID SF's weighted	.0205 (.012)	.93 (.99)	.93 (.99)	1.0

HUNTING AND FISHING RESULTS[3]

	Average size of Supply Factor	CORRELATIONS ANOVA SF's unweighted	ANOVA SF's weighted	AID SF's unweighted	AID SF's weighted
ANOVA SF's unweighted	.0660 (.030)	1.0	.92 (.72)	.92 (.97)	.88 (.98)
ANOVA SF's weighted	.0666 (.037)	.92 (.72)	1.0	.89 (.71)	.91 (.72)
AID SF's unweighted	.0708 (.030)	.92 (.97)	.89 (.71)	1.0	.94 (.99)
AID SF's	.0542 (.026)	.88 (.98)	.91 (.72)	.94 (.99)	1.0

1. For actual values of the various supply factors referred to(see Table 3).

2. The average size is the root mean square average size and does give one some idea of how much on the average a supply factor correction to a prediction will be. The number in brackets gives one an idea of the average size of the standard deviation in a supply factor though as one can see from Table 3, standard deviations tend to be somewhat proportional in size to the supply factor to which they relate.

3. The numbers in brackets following the supply factor correlation coefficients are weighted correlation for the standard deviations in supply factors. The generally high value reflects in part that standard deviation depends on sample.size. The correlation offabout .7 for the weighted hunting-fishing supply factors standard deviations simply shows the influence of introducing the variants corrections for obeervations rather than weighting each observation by one as is done in AID and ANOVA analyses. The .9 correlation of the supply factors from the weighted model with other supply factors shows that weighting only has a "drastic" effect on coefficient standard deviations, not on coefficients. (This holds when the model is appropriate to the data.)

But, what is being alluded to becomes more clear when the actual results of analysis are presented, for now it should suffice to indicate that the actual regressions performed produce a weighted sum of residuals. If, for example, socio-economic effects are estimated and eliminated then supply effects are computed or if the socio-economic variables are included supply factors are determined by a formula which indicates that a supply effect is a weighted sum of residuals:

Supply effect for = (@E W(i) residual(i))/(@E W(i))
region r for an
activity

The weighting of residuals to reflect the variance in observations is mentioned in TN 6 and 20 and discussed in detail in the Cicchetti and Smith article which appears as an appendix to this volume.

RESULTS

The results of this analysis are presented in Tables 1 through 5 and Figure 1. Tables 3 and 4 permit the reader to see in certain respects how different ANOVA and AID analyses compare. In particular Table 2 presents regression coefficients which are laid out in such a way that one can see that, whether or not supply factors are incorporated into the snow skiing model or the hunting and/or fishing participation model, the effects of socio-economic variables remain the same. In particular if one looks at the first and third columns of Table 1 one finds the effect for level 1 of VAR006 (being female) indicated by a coefficient of -.00766 with a relatively small standard of deviation of .002. This value occurred when only socio-economic effects were considered in developing a model. This coefficient only shifted in value to a minus .00759 when origin effects were introduced. This shift is well within one standard deviation. A similarity of coefficients is even more striking when one looks at effects for different levels of variable 007. These shows the effects of age on participation. For example the coefficients for the youngest age group is .0288 whether or not origin effects have been incorporated into the snow skiing model.

In Tables 1 and 5, it will be noticed that the F - test for the regressions are given. All of the models developed have F - test values which are very highly significant. At the same time all of the models have R^2 value which are low enough that many people would consider the models quite unacceptable (on this matter see particularly TN 35 and comments in TN 6). In reality the low R^2 values only reflect the problem involved in predicting the actions of an individual. As shown in TN 6 when predictions are made for many people the accuracy of results on what percent will participate in an activity can be plus or minus a few

TABLE 5

STATISTICAL TESTS FOR THE SIGNIFICANCE OF THE SUPPLY FACTORS

	SNOW SKIING			HUNTING AND FISHING			
	ANOVA Results with/without Origins	AID Results		Unweighted ANOVA Results with/without Origins	Weighted ANOVA Results with/without Origins	AID Results	
		Unweighted	Weighted			Unweighted	Weighted
TSS	1228	1211.29	25257.4	3736.36	35964.101	3699.24	25244.2
ESS#1	18	17.5663	231.698	82.68	4204.461	78.5557	369.496
R(2) (%) ESS/TSS	1.467	1.450	0.917	2.212	11.69	2.124	1.464
RSS#2	1210	1193.7237	25025.70	3653.68	31759.64	3620.68	24874.7
F-Statistics#3	6.04	5.98	3.77	9.18	5.37	8.82	6.02

1. D.F. for ESS = 62.
2. D.F. for RSS = 25,296 - 1 - (15 + 62) = 25,218.
3. An F(62; 25,218) greater than 1.90 has a probability less than 0.001 of occurring.

Note: Total sum of squares (TSS) and explained sum of squares (ESS) for the weighted ANOVA results for Hunting and Fishing were based on TSS and ESS in Table I using the following formulae:

TSS (weighted) = TSS (weighted ANOVA results of Socio-Economic effects and origin effects)
- k ESS (unweighted ANOVA results of Socio-Economic effects only)

ESS (weighted) = ESS (weighted ANOVA results of Socio-Economic and origin effects)
- k ESS (unweighted ANOVA results of Socio-Economic effects only)

where k = TSS (unweighted ANOVA results of Socio-Economic effects only)
TSS (unweighted Socio-Economic and origin effects)

percent using CORD Study data.

Those readers who are familiar with the AID program will understand why the coefficients from the AID program that explain behavior in terms of socio-economic characteristics are not included in Table 2. Those who are not familiar with the AID program may wish to refer to CORD Study TN 4 or 27 or to a reference on the AID program (see Reference 20). When the AID Program is used people are grouped into relatively homogeneous clusters based on complicated collections of socio-economic characteristics which serve to identify people for whom an appropriate estimate of their probability of participating in an activity is the group mean for the terminal group they are assigned to based on the socio-economic characteristics they have. The important information on AID analysis which can be displayed in a summary form is the size of the group which are identified by the AID Program and the various means for these groups. Actually these means are the prediction that would be made if one wished to estimate the probability participation for the people in a particular group.

From Table 2 it can be seen that there was a mean participation for the whole universe of .05344 (the average value of the unweighted dependent variable) for snow skiing.

From Table 3, one can see that there was one group of 411 people identified for which a most appropriate prediction of their probability of participation was .24. Also, around 2,500 people out of the 25,000 for whom the model was developed are in groups 20, 21, 6, 2 and 16 for which the mean for the group is more than twice the mean of the dependent variable. One notes a similar pattern for the AID results on hunting and fishing. However for hunting, it is much more striking because based on the mean of the dependent variable of about .2 one suspects that a person has one chance in five of being a hunter yet in the AID analysis certain socio-economic characteristics are sufficient to identify people to the point that one can reasonably assign these people one chance in two of participating in hunting. At the other extreme with respect to hunting and snow skiing one can see that there are large numbers of people in groups with group means that are less than half of the average participation rate for the population, below .10 and below .027 respectively.

The results on the AID analysis that have been presented are obviously unsatisfactory to one who is interested in why a certain group has a certain group mean. However, to present the detailed results on how different groups were defined in terms of socio-economic variables and to comment on this takes one into matters which are quite irrelevant to the general theme of this paper. For that reason further AID results are not included here. The data used in this analysis are available from the Waterloo Research Institute, Leisure Studies Data Bank should someone

wish to pursue the matter of why certain AID clusters occur.

Table 4 is where one for the first time sees the actual supply factors which were calculated in this analysis. One can manually compare the supply factors to see that the supply factors computed when AID was used to explain participation in terms of socio-economic variables agrees with supply factors computed when ANOVA was used. However, Table 5 provides weighted correlation coefficients which will probably give one a better idea, at least a quantitative idea, of the degree of agreement between the different supply factors. Standard deviations in the supply factors were used as weights in computing the correlation coefficients. The correlation coefficients between the 3 sets of snowing skiing supply factor and the four sets of factors for hunting and fishing being in the general order of magnitude of .9 indicated that any one of the supply factors explains around 80% of the variance in the other supply factors for the same activity. And, given the standard deviations in the supply factors this level of explanation is all that can be expected. So, the results of the analysis appear very good in one respect. That is that the supply factors computed from the AID and the ANOVA analyses agree very well. One could say that this agreement shows something about the reliability of the supply factors when they are determined in a similar way.

But one may be concerned about the validity of these supply factors. Does the magnitude of the different supply factors show something that would be expected in terms of what is known about the distribution of supply for snow skiing and for hunting and fishing in Canada? Now, rather than meticulously examining the numbers in Table 4 in trying to answer this question one can look at Figure 1 in which origin information and supply factors are displayed together. There one sees that people hunt and fish and also snow ski in the mountains of Western Canada. This is no surprise. One sees that skiing is below the national average in the Canadian prairies where supply conditions are poor and it is well above the national average in the areas around Quebec City and Montreal where there is an abundance of ski slopes. Again one sees large negative supply factors in Southern Ontario and the Maritimes which are areas which offer few opportunities for snow skiing because of the weather. It is left for the reader to examine the differentials in detail to decide if certain details correspond with what he knows to be the case by experience. However in this examination the reader should keep in mind that some of the regression coefficients supply factors do have rather large variances. For example, the difference in the supply factors for Regina and Saskatoon, Saskatchewan could be taken as reflecting the existence of the Blackstrap "Mountain" ski development near Saskatoon while Regina has no comparable supply but this is a tenuous conclusion because it is based on rather weak evidence. Still Thunder Bay and other special skiing areas do regularly appear to have the supply factor which one might expect.

Given the statistical significance of many of the supply factors and given the way that the relationship between the supply factors and the areas with which they are associated makes sense in terms of what most Canadians know about supply for the activities considered, there may appear to be little reason to give statistical tests for the significance of supply factors. However, such significance tests are presented in Table 6. There one sees that all of the supply factors computed are highly significant in terms of the sums of squares which they explain above and beyond sum of the squares that are explained by socio-economic variables. However, the reader may find Table 6 particularly distressing in terms of the R^2 values presented there. The feeling may be that it was bad enough to see R^2 values of .05 or .10 for the socio-economic effect models but the values for supply factors are absolutely too low to be meaningful. Actually, they are not too low to be meaningful. The fact that supply factors explain another 1.4% of the variance in participation after socio-economic variables have explained 5% really shows that supply factors are too important to ignore if models are to be developed that are to be at all accurate in explaining people's participation in activities in particular areas of Canada.

One can see the importance of the supply factors, even though they only increase R^2 by 20 to 30%, in terms of the following argument. Consider that R^2 is increased from V by an amount rV where r is say .25 (as it was when supply factors were introduced into the unweighted model to explain participation in hunting and/or fishing). It may be noted that for the relation defined above to hold the contributions of the supply factor to R^2 are not defined by r but by the square root of r. This is the case because the sums of the squares of these effects, which are orthogonal to the socio-economic effects must add up to rV and if the socio-economic factors have an amplitude X and the supply factor an amplitude SQRT(r)X the sum of square is X^2 + $(rX)^2$. So, in practical terms if r is .2 or .3 this implies that supply factors are on the average 40 to 60% of the magnitude of socio-economic factors. If effects of this size are ignored in making predictions for particular geographic areas one can see that substantial errors could result. However, one must recognize that the mean participation level is not considered when R^2 is computed. Thus, though the preceding shows that the small contributions of supply to R^2 should not result in one considering them to be unimportant compared to socio-economic variables, other matters should be considered in determining their overall importance in making correct predictions. Consequently, this matter is returned to in the discussion section of this paper.

DISCUSSION

The results presented in the last section are quite definitive. They leave no doubt that there are significant supply effects that can be calculated for different regions of Canada that help explain the amount of participation in various activities. However, as is made clear in the appendix of this note, extremely large sample sizes are required to measure these supply effects accurately enough so that they can be subjected to secondary analysis focusing on how actual supply "on the ground" is related to perceived supply. Relating the regional supply effects to actual "on the ground" supplies or measures of perceived supply can, and should be, the goal of future work.

This future work, however, should proceed with caution. As was pointed out earlier, original supply factor research involved information on the incidence of participation (yes or no). Some measure of supply based on the frequency of participation might also be developed. But if it is, it is plausible that two different analyses, one based on incidence and one based on frequency, will result in different supply factors. If so, the implication is that different models should be used by planners according to the measures they are trying to predict. This is what is implied in the Cicchitti, Senecca and Davidson work (see TN 34).

Another matter of importance regarding the models is that many of the socio-economic variables considered as causing or shaping participation are not truly causal. More precisely, some are antecedents of other causal variables. It is only later in this volume in the review of Chapter VII and in Chapter IX of this volume that any comment is made about the need for a better and more precise understanding of causal variables in modelling. For example, age is a partial antecedent to education, which is in turn a partial antecedent to income. The result is that the socio-economic variables included in a regression model are not truly independent of each other. Participation is a dynamic phenomenon and the type of analysis presented in this paper is static or cross-sectional. At best, the solutions presented in this paper are approximations of an equilibrium condition and approximations are where research must start. For the purposes of this paper and from an empirical viewpoint, the measurement of supply effects does not depend on the internal structural validity of the relation between socio-economic variables implied by the models used. The critical point for the work here is to simply include certain variables. In other words, there is a need for more work on identifying and measuring the causal variables of participation, but this is not a crucial issue in this paper.

A related issue concerning the development and refinement of a model is that the supply factors developed here were achieved under the assumption that all people have knowledge of the supply of facilities for given activities.

Future computations could be based on interviews with only those people who really do know something about the supply of facilities. Or, more generally, a model could be formulated in such a way that the response of a given person about his participation is weighted according to the amount of knowledge he has about the supply of facilities for the activity under consideration. A model based on this type of formulation might from an aggregate view adequately combine considerations both of the incidence of and the frequency of participation.

The supply-knowledge component should probably be entered into a projection model as a multiplicative component rather than as an additive one. The basis for this is that if the user perception of supply is zero, there will be no participation. This effect is missed if the supply-knowledge component is additive. If the reader is going to get into the kind of considerations just raised, he should also be aware of an issue discussed by Cicchetti, Seneca and Davidson. These authors suggested that people who participate at different rates should actually be studied by using separate models. A similar conclusion is implied in the cluster analysis presented at length in CORD TN 10 and commented on in TN s 3, 32 and 37. In these Notes the issue of participation is not simply related to a single activity, but rather the question is raised (as it was in Reference 00) whether or not groups of activities should

As indicated above, the basic computational strategy used here utilizes actual participation data to get a measure of how human behaviour deviates from a model which assumes supply is uniformly distributed. It is necessary that the other assumptions behind the supply factor computation should be made explicit since they concern the interpretation of the supply factor derived here. First it is assumed that there are no regional effects resulting from a unique cultural milieu. Specifically, it is assumed that cultural factors within any of the 62 regions considered in this paper do not result in a change in participation (by modifying the expression of causal socio-economic variables) that might be confused with supply variations. Similarly, it is assumed that any socio-economic variable not included in the analysis either has no effect on recreation participation or it averages out within each of the regions. Also it is assumed that supply factors do not explicitly measure the effect of weather in a given year. For example, a cold summer in the Maritimes and good weather in the Prairie Provinces in the year data were collected could result in a supply factor showing that the supply of opportunities was much larger in the Prairies than it was in the Maritimes because of the effect of weather in modifying average participation patterns. Broadly interpreted, this would be true. The opportunities for a satisfactory recreation experience would be greater in those areas with good weather, but, this interpretation of supply should not be confused with "what is on the ground". This problem of interpretation must be kept in mind continually, and either

considerations of the effects of weather should be taken into account or evidence should be presented which suggests that weather had negligible distorting effects with respect to a given activity.

Finally and probably of most practical importance is that though supply factors do not add much to R^2 by their inclusion in a model they are absolutely crucial parameters. Consider for example that for snow skiing there was an average participation rate of about .05. Now, as one can see from Figure 3 for much of the Prairies and Atlantic Canada the supply factor had a value of around - .025. If an ANOVA model were used to make predictions based on national parameters they would imply about 1 person in 20 participated when actually only about 1 in 40 did. The magnitude of error which would occur as just indicated is certainly not acceptable in many cases (possibly most) if planning is to be based on estimates.

The preceeding example does not infact show how poor estimates will be in an exceptional case but rather, since many supply effects are larger in absolute value than .15 and some larger than .35 in absolute value, large errors in predictions due to failure to consider supply factors can be expected to be usual rather than unusual. Certainly the result just cited show that the accurracy estimated using the procedure given in TN 6 is illusory if a supply factor is not included in the model used to make predictions. The supply factor must be included to remove model bias. If supply factors are independently determined (either from residuals of a regression where socio-economic effect were determined or from a separate data set), then the kind of variance estimates obtained in TN 6 need only be modified by adding on variance related to error in the supply factors to deterime accuracy estimates:

Added variance = ∂E ((Number of people in area r) *
(Variance in supply factor for r))

WHERE the sum is over all areas being considered.

Obviously, when supply factors are not accurately known the variance from this source can be larger than error from other coefficients.

CONCLUSIONS

This TN has shown that, under a set of reasonable assumptions, highly significant supply factors can be derived to show how participation varies among regions within Canada. Unfortunately this variation can be the result of variations in physical supply or, possibly, of cultural differences or other variations. The authors feel, however, that supply differences are the most important cause of variation for the activities considered. So a next step is to try to explain the effects measured on the basis

of physical supply data modified by by variables reflecting such factors as advertising. Such work is quite possible because some of the coefficients measuring the effects of supply are accurate enough that they can be compared to regional inventory study data.

In conclusion, this paper has achieved its primary purpose of deriving supply factors. Some other interesting conclusions have been reached about the adequancy of the model, data requirements and so on which should be of help to researchers who may wish to further this work. In particular this paper has given some limited answers about how to proceed in defining a supply parameter for demand analysis, what expected levels of explained variance will be and so on. Possibly of most importance are the guidelines in the Appendix which show the number of observations needed in any region before a researcher can expect to have much chance of deriving adequately accurate supply factors to carry out further analysis. With these guidelines studies which go beyond this one can be designed to succeed rather than to fail.

THE PROBLEM OF HAVING ENOUGH OBSERVATIONS ON A DESTINATION AREA THAT SUPPLY EFFECTS WILL BE STATISTICALLY SIGNIFICANT AND/OR ACCURATE FOR FURTHER ANALYSIS

Consider that a set of supply effects r(i)'s are to be computed for a number, N, of subareas of a country or province. Let an estimate of the participation that would occur if supply were at the same level in all regions (and there were no cultural factors, etc.) be PE(i,x) for an individual x in region i. Then, one can argue that an appropriate estimate of the real probability of person x participating is:

$$P(i,x) = PE(i,x) + r(i)$$

Given the equation above, it is possible to derive some equations that can be used:

(1) to determine if the variances in actual estimated r(i)'s are what they should be expected to be and
(2) to determine the approximate number of observations necessary in a region i to have a certain probability that a supply effect will be estimated with, say, a S.D. R(i), about the value of r(i) (e.g. S.D. R(i) approx = .1 or less with a certain probability).

Still it must be recognized that one must be interested in having a general accuracy level for a collection of geographic areas because supply effects are calculated around a certain mean and are determined in such a way that they add up to zero. This means that some supply effects are going to be small and others are going to be large simply by virtue of the fact that one area has an "amount of" supply which is close to a national average and another area deviates quite substantially from this. So, it is reasonable to consider that in research design one should have about the same number of interviews in the different geographic areas in which there are roughly the same number of people so no matter which supply factor turns out to be large and which turns out to be small the larger ones will meet some accuracy criteria in terms of S.D. R(i)/r(i).

In expressing error the acceptable amount of error can most conveniently be expressed with respect to some measure of the average deviation of the supply factors from their overall mean value of zero. One convenient measure of this type is R = (1/N) times the sum of the absolute values of the supply factors: in other words a convenient measure against which to assess error is the average absolute value of the supply factors. This number is in some way a measure of on the average how large the negative and positive deviations about the mean supply factor values of zero tend

to be so let:

R(i) = (1/2N) @E | r(i) |

Now consider that in most regions the average value of PE(i,x) over all persons in i is near to PBAR (eg. ± 20%) and that by definition R/PBAR approx = PRO1. To be specific, if the average participation rate for hunting for males is .15 and R = .05 then PRO1 = .33 which means that the mean supply factor is of such a size that the effect of its average value is a ± 33% change in participation.

Further regarding notation, if one is concerned with the accuracy of the r(i)'s the concern can be expressed by indicating that the variance in an r(i) with an estimated value of about R should be:

PRO2 =
(standard deviation in r(i) with an estimated value of R)/R

and, in the context of making estimates the standard deviations in r(i)'s are influenced by:

(1) The accuracy with which PBAR is estimated (which can be estimated by methods described in TN 6 which can be approximated as indicated subsequently) and
(2) The variance in the given r(i) about the mean referred to in point (1) immediately preceding.

Now, with N regions and M observations in each, participation PBAR may be considered to be estimated based on MXN observation of a zero-one variable: in other words PBAR = (# of participants)/MXN. It is well known that this type of estimate has a variance approx = PBAR(1-PBAR)/ MXN. As for the variance in r(i) with a value of R, for the region r(i) there are M zero-one observations which by assumption are from a distribution with p = PBAR ± R so, again quoting the well known formula, the variance in r(i) given PBAR approx = P(1-P)/M. One must consider PBAR because the results of a particular analysis is being considered and the value of it in this case depends on the statistical deviation to be expected in r(i) measured from the true PBAR, E(PBAR) and on the additional variance introduced into the estimate of r(i) because PBAR is estimated. Adding the two independent variance elements:

$$V = \text{variance in } r(i) = \frac{PBAR\ (1-PBAR)}{MXN} + \frac{P(1-P)}{M}$$

If N is 20 or 30 and P(1-P) is not much larger than PBAR(1-PBAR) (which is most unlikely), then the first term on the right can be ignored so:

$$V \text{ approx} = \frac{(PBAR \pm R)(1-PBAR \pm R)}{M}$$

And if V**1/2 (= SDR, the standard deviation expected in an r(i) of size R) is to be (PRO2)R and R is to be (PBAR)PRO1 for the reason introduced earlier:

$$[(PRO2)(PBAR)PRO1]^2 = (PBAR \pm (PBAR)\ PRO1) \pm (PBAR \pm (PBAR)PRO1^2)/M$$

Multiplying through by M and dropping the $(PBAR \pm R)^2$ (1) because this will usually be 1/4 or less and thus will be negligible compared to the other term on the right and also (2) because the results have to do with a statistical approximation:

$$M(PRO2)^2(PRO1)^2PBAR^2 \text{ approx} = PBAR(1 \pm PRO1)$$

$$M(PBAR) = \frac{(1 \pm PRO1)}{(PRO1^2(PRO2)^2)}$$

The formula given above allows one to show why some of the r(i)'s given in the paper have the level of accuracy that they do and why it was a relatively hopeless matter to estimate supply effects for 75 areas based on 4,000 observations (the attempt described at the beginning of the paper). These examples allow one to see how the formula may be used to estimate the size of sample necessary to estimate r(i)'s accurately enough that secondary analysis to determine how r(i)'s are related to what is on the ground can be carried out successfully.

One should notice in what follows that it is critical that one know rough values of PBAR and of the r(i)'s or be willing to make the success of potentially very expensive research dependent on the assumption that PBAR and r(i)'s will have a certain range of values. Furthermore, it should be noted that the appropriate value of the constant PRO1 is related to the choice of PBAR and r(i),s. The value of PRO2 is independent of the other values in the sense that it is hard to visualize a successful analysis of say 50 or so residuals to relate them to what is on the ground unless PRO2 is .1 and it should probably be more in the range of .05 or .02. Its value must depend on what "accuracy in the r(i),s" is necessary to achieve the analysis objectives.

To begin with the matter of the accuracy of supply factors, even the possibility of detecting them with 4,000 observations, consider that with 4,000 observations and roughly 70 parameters being estimated, if the r(i)'s are random:

$$X^2(4000-70) = \frac{@E\ r(i)\ \text{for the person})^2}{\text{variance expected for the person}}$$

WHERE X^2 is Chisquared with m degrees of freedom;
variance expected in prediction for a person may be taken to be approximately the variance in PBAR.

For X^2 with this number of degress of freedom to be significant at the .05 level, the well known approximation for a X^2 with over 30 degress of freedom gives:

$$1.65 \le (2(X^2)**1/2) - (2(4000-70)-1)**1/2$$

and solving the above, recognizing that (4000-70), the degrees of freedom of the X^2, one obtains:

$$1.1 \le \frac{X^2}{\text{degrees of freedom for the } X^2}$$

So from the above one concludes that on the average r(i)'s must exceed their variance by 10% if they are to produce a X^2 that can be accepted with 95% certainty as significant. For this to be true on the average, $(1/PRO2)^2$ should be greater that 1.2 or in other words PRO2 should be .9 or less. By the formula derived earlier for 4000 observations in 75 areas M = 4000/75 = 53. A typical PBAR for the CORD study activities of which we must chose an activity for males is .15. Finally, the earlier results show that R, as defined earlier, is only about 1/4 PBAR. Thus:

$$53(.15) = \frac{(1-1/4)}{(1/4)^2(PRO2)^2}$$

$$PRO2 = \frac{(12)**1/2}{8} = 1.22$$

Now even if R/PBAR = 1/3 the chances of results being accepted as significant are questionable because:

$$PRO2 = \frac{(9 * 2/3)**1/2}{8} = .86$$

However, in either case if the sample size had been three times as large M=150 then there is no question that the results would have been statistically significant.

For another example, by looking at the weighted regression results for activity one, given in Table 1, one

sees that for r(i)'s between .1 and .2 the statndard deviations are about .02 or .03, which is about 20% of their expected value. Now, for these data there were on the average 400 observations in each of 60 origin areas:

PBAR = .23 and thus PRO1 approx = .1/.23 approx = 1/2 so that

$$PRO2 = \left(\frac{1 + PRO1}{M(PBAR)(PRO1)^2}\right)^{**1/2} \text{ approx } = 0.14$$

The value of .14 is lower than the .2, or so observed, but since results presented in TN 20 show there are structural problems with the model and because the parameter estimates are not efficient weighted estimates (see Reference 00) the difference is not distressing. Also it should be noted that there are not exactly 400 observations in each origin area and this complicates matters.

For future analyses of the r(i)'s to determine how they relate to the supply that is on the ground simple statistical significance of the r(i)'s is not enough. For example the goal might be to study a relation like:

$$\text{Supply measure} = ∂E \frac{(\text{attractiveness})[a]}{(\text{distance})[b]}$$

As indicated earlier for such analyses PRO2 should be .1 and probably less. So, in the context of the last two examples, one finds that M should be:

$$M = \frac{1}{.15} \quad \frac{(1-1/4)}{(1/4)^2(.1)^2} = 8000$$

So, for 75 areas 600,000 interviews would be needed with larger r(i)'s:

$$M = \frac{1}{.15} \quad \frac{(1 - 1/3)}{(1/3)^2(.1)^2} = 6000$$

Obviously, research to define the relevant relation between what is on the ground and peoples' behaviour is going to have to be well planned so that data need be collected in only 5 to 10 areas in which there are the necessary distinct supply difference to allow the adequacy of parameters to be estimated and a relation to be tested.

G. Ewing

TN 16, 3 and 29 provide examples of three distinct approaches to the measurement of the supply of spatially distributed facilities. The first paper describes an ad hoc measurement technique for the most part based on unstated assumptions about user behaviour, while the latter two papers explicitly or implicitly assume that evidence from recreation behaviour is necessary to estimate a supply measure. Recognizing that the attractiveness and distance exponent parameters in TN 3 can be empirically estimated, the major distinction between it and the last paper (TN 29) is that in the latter estimates of a place's supply are made without the analytical problems and the expensive, detailed behavioural data associated with estimating a distance exponent and separate attraction values for each activity-site combination. It may be argued that this saving is made with a possible sacrifice of validity. How can such supply factors be changed to reflect changes made in the supply of an area? In a similar vein, TN 16, which requires the least specialized (and therefore least costly) data and produces the most stable results in terms of test-retest reliability, makes a still greater sacrifice of validity. Thus, the three papers in the order 16, 29, 3 reflect a progression in the trade-off between ease of data collection and supply estimation on the one hand and the ultimate validity on the other.

One thread which emerges from these papers is that total participation increases as total supply increases, although greater supply leads to greater competition for customers being faced by any single recreation site (in competition with the others which go to make up the total supply). Inevitably there is a level of total supply above which diminishing returns set in for individual sites. But at lower levels of supply it it quite conceivable that the competitive effect of additional supply is more than offset for the individual site by the increase in overall participation generated by the supply increase. In the private sector it is conceivable that the supply level above which diminishing returns set in for individual sites might be the optimal supply level from the entrepreneurs' point of view. (For other approaches to this problem, see Reference 00.) However, in the public provision of recreation sites, a higher level of supply might be deemed proper since it would produce a lower density of use at individual sites and perhaps, therefore, a higher quality of recreation experience.

TN 16 illustrates a conventional "accounting" method of measuring supply. In order to make a variety of decisions, the "accountant" requires operational definitions of variables (such as the amount of camping facilities at a site) and other factors used to compute total supply (such

as the average length of stay and the number of usable days at a site per year). The basic question about the validity of this approach relates to whether users of these facilities perceive supply in terms of the same variables and factors as does the planner "accountant". This is a valid consideration if it is argued that site use ultimately depends on the (perceived) quantity and quality of supply.

In general, the supply measure is highly dependent on a host of often untested behavioural assumptions about such things as the acceptable density of sunbathers on a beach, the average length of stay at a site for a particular activity, and the average friction of distance for an activity. Without precise behavioural information to replace these assumptions the available measures of recreation supply are at best tentative, if not misleading. Only if there happened to be a high correlation between the perceptual measures and the "accountant;s" measures would the difference in the users; and planners; accounting procedures be of minor importance. In that case, planning a proper regional distribution of recreation facilities could be properly based on the "accountant's supply measures". The main advantage of the method is the relative ease of supply measurement and the test-retest reliability of such measures.

The fact that no variable measure of distance between users and sites is incorporated in the supply calculation, in the manner (say) of a market potential model, might be thought of as a serious weakness of TN 16, which simply defines sites as equally accessible provided they can be reached "by car and/or after a short walk". The degree of accessibility of recreation sites, which range from a few miles to hundreds of miles from population concentrations in some cases, is clearly a critical determinant of the effective supply of recreation sites. However, the attendant problems of adding a distance component to a supply measure are well illustrated in TN 3, which shows that the measure of an origin's supply of recreation facilities varies condiderably with changes in the size of the distance term's exponent. This variation would be of little concern to the recreation planner if the supply measures of all places changed by the same proportion, as the value of the exponent was changed.

It can be indirectly inferred from Table 1 in TN 3 that the foregoing is not the case. For example, the larger the exponent, the less important are more distant recreation facilities in contributing to an origin's overall recreation supply. Consider two origins, one with major recreation sites nearby, the other with its major sites at a greater distance. If a large distance exponent is assumed, the first origin has much greater effective supply than the other, but if a very small exponent is assumed, the differences between the two origins; supplies is slight. Inevitably, planning decisions as to whether an origin is relatively undersupplied or not, particularly in situations more complex than the above example, depend very much on the

distance exponent assumed. Though TN 3 does not discuss empirical estimation of the exponent, it does clearly illustrate the effect that variations in the distance exponent have on location-dependent supply measures, and the importance of reliable empirical estimates of the distance exponent for recreation supply measurement.

In the same paper it should be noted that in defining the alternative factor as a measure of overall competition for the users from one origin, the implication is that t(ij), the number of trips from i to site j, is partly a function of the level of competition from other sites. This in turn implies a choice model of trip making, in contrast to the widely-used unconstrained gravity model which assumes t(ij) to be a function of only the characteristics of i and j and their distance apart, but not related to the nature of alternatives. Suprisingly, no direct empirical comparisons have been made of the predictive power of these two types of model of interaction behaviour. Since the gravity model can be seen as a special and simplified case of the choice model incorporating an alternative factor, an obvious question is whether the more complicated, general model enhances prediction of trip distributions sufficiently to merit the extra calibrating effort that its use involves.

One form of indirect answer to this question is to acknowledge that high R^2 values have often been achieved in calibrating gravity models against trip distribution data. However, in their concluding statement, Beaman and Smith caution us that high R^2 values are no guarantee of the appropriateness of a model. An illustration of this point, in the form of a high R^2 value obtained using a misspecified gravity model calibrated against data that were in fact consistent with the more general choice model, is provided in Reference 00. Recognising the problems associated with empirically estimating distance exponents as well as site attractiveness scores, TN 29 seeks to avoid these parameter estimation problems entirely by adopting a different, though still behavioural, approach to the measurement of supply. It attempts to measure the local supply of facilities for a recreation activity by using as a surrogate of supply the participation rate in that activity suitably discounted in terms of local socio-economic population characteristics. However, certain interpretation problems do arise. The reasons why over-or under-participation in any region is inferred to indicate an over-or under-supply of facilities in that region, rather than to reflect some other possible causes, is discussed in the paper itself.

Two associated issues deserve comment. Firstly, the inclusion of city-size levels as predictors of participation along with socio-economic variables implies that some of the regional variation in participation is related to the size of the city participants live in. However, unlike the effects on participation of education or income, over which the recreation planner has no control, the effect of city size level may reflect locational constraints on participation similar in effect to inaccessible supply.

Specifically, the larger the city, the less readily accessible are surrounding recreation facilities on account of the time involved in travel within larger cities. Thus, a lower participation by large-city dwellers may reflect a less accessible supply of recreation facilities, rather than some innately lower propensity to participate. It could be argued, therefore, that in Equation 3 in TN 29, it is improper to include a city-size effect as that will decrease the value of the expected level of participation of individual i, in region g, in activity a. Without that term in Equation 3, the resultant larger values of in some areas would decrease the supply factor estimate, and if the above assumption is accepted, more accurately reflect the extent of (accessible) supply in areas with large cities. Clearly the recreation planner cannot influence personal attributes such as education or income. Yet he can modify the effect large cities have on their inhabitants, for whom rural recreation facilities are made more distant by the intervening speed-restricting urban space. If supply factors were low for these areas, he could locate recreation facilities close to the edges of, or within the boundaries of, the larger urban areas. Certainly the question of whether to exclude that factor from Equation 3 deserves further consideration.

A second issue relates to the assumption implicit in the paper that there is a relationship between participation levels and supply levels.

From a positive view it is possible to consider supply as measured in TN 3 by Beaman and Smith and as measured in this paper as complementary. In other words supply factors can be viewed as intrinsically a perceptual measure of supply as reflected by people's participation, whilst the gravity model measure:

@E [A(j)/F(D(g,j))]

can be considered as a more direct measure of supply "on the ground". This being so, a useful exercise would be to consider supply factors as the dependent variable and alternative factors as the independent variable in a possibly non-linear regression model. Clearly, if the latter were a good predictor of the former, knowledge of the regressed relationship would simplify the estimation of future participation increases in any area resulting from increases in the supply of particular recreation facilities. And, of course, the shape of the function relating the two variables would provide valuable evidence about the varying marginal utility of extra supply for any given existing level of supply as measured by the independent variable.

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THEORY ARTICLES

INTRODUCTION

Even though it is possible to give dates at which the different theory articles in this chapter were prepared, and to relate the theory articles to CORD Study work that was going on, this would not give a true picture of why these theory articles were written. For example, it was quite by accident that Roy Wolfe provided a copy of his "inertia model for travel" to the author of the "Distance of the Function of Distance" paper. Wolfe's paper (see Reference 32), which eventually appeared in the Journal of Leisure Research, raised questions that had not been brought into as clear a focus by the CORD Study research underway in 1972. In the CORD Study, the distance functions that were being used were either the traditional distance to some exponent type of function or the kind used by Cheung in TN 1 (which was selected because it gave a better fit to available data than traditional distance functions).

Neither the choice of a function because it gives a good R^2 in a particular regression, or the choice of a function because other people have used it, is particularly satisfying to some researchers. In his paper, Wolfe was making the clear suggestion that behaviour should play a more important role in the choice of the functions used in gravity models. He presented certain plausible ideas, but it is these very ideas and disagreement with the way they were followed through logically that prompted the preparation of TN 14.

TN 32 and 37 are closely related to each other and should be considered in conjunction with TN 10, which presents the applied work that shows the practical relevance of pursuing the clustering ideas discussed in the other two papers. It was informal discussion of the ideas presented in TN 32 (carried out long before the note was prepared) that prompted the quantitative work reported on in TN 10. When quantitative results became available on how the Canadian population would be classified into clusters based on the activities they participate in, it was very clear that the original ideas that had prompted the empirical work should be documented. So, this was done in order that the broad implication of the empirical work would become clear from a theoretical perspective.

A meeting of CORD Study researchers and a meeting of the Canadian Parks and Recreation Association provided the final stimulus necessary to prepare TN 32 when it was recognized that there was a need to clarify to recreators and professionals in the field of recreation the fact that

people participate in one activity independently of another.

Actually, the first version of TN 32 contained much of what was ultimately included in TN 37. The author of the latter had long been involved in considering how one should model people's behaviour when participation in a number of activities at a number of facilities was involved. So, when the clustering approach was being described in early drafts of TN 32 a number of the issues were woven into his own paper. However, the appearance of the Hendee and Burdge article on substitutibility and its practical applications in the Journal of Leisure Research prompted a sorting out of ideas. A number of considerations that would stand on their own were placed in a review of the Hendee and Burdge article. This left a fairly pure discussion of clustering and its practical implications (from a theoretical perspective) in TN 32.

DISTANCE AND THE 'REACTION' TO DISTANCE AS A FUNCTION OF DISTANCE

J. Beaman

ABSTRACT

"Distance and the 'reaction' to distance as a function of distance" is a phrase designed to emphasize the need for more analysis of the behavioural significance of gravity functions. This paper, in pursuing the behavioural significance theme, concentrates on research related to the "inertia models" suggested by Wolfe. The most important concept presented is that if an inertia model of travel behaviour of the type Wolfe describes is accepted, then the decision to visit a given location must involve a reaction to distance in marginal rather than absolute terms.

To quantify, the paper focuses on the effect of going one more unit of distance beyond a given point. This quantification being carried out leads to the conclusion that analysis of reaction to distance in marginal terms should be based on the properties of an "impedance due to distance function", IDF(d). A discussion of five gravity functions provides a basis for illustrating points and methods introduced. IDF(d)'s are derived for the functions considered. Conjectures on the response to distance suggested by the functions are checked by reference to the impedance of distance functions derived for the gravity functions introduced.

Conclusions relate to the fact that it is easy to misinterpret the significance of gravity functions as to how they imply decisions are made if one only looks at the shape of such functions. It is shown that in cases where one may think each new mile to be travelled offers more resistance than the last, each new mile offers less resistance or constant resistance.

PURPOSE

This paper presents a theoretical discussion and findings on "distance travelled as a function of distance". The purpose is not to fit functions to data but to clarify the behavioural interpretations that should be applied to functions which appear to fit available data.

Wolfe (see Reference 32) has discussed what is usually considered to be the "distance part of a gravity function". General discussion on gravity and potential models is adequately covered in such sources as Olsson and Wilson (Reference 20, 31). Ginsberg has formulated a Markow Renewal Model that embodies the inertia model concept, but only mathematically oriented readers would find Ginsberg's formulation (Reference 12) easy to follow. A paper in the recreation area employing a Markow Renewal Model is Gorman, Peterson and Lime (Reference 13). Of course, Wolfe is not the only one (or even the first) to conceptualize the effect of distance on length of trips, although his explicit discussion of distance travelled as a function of distance is a seminal contribution. In fact, inertia effects are implicit in a variety of formulations. Stouffer's formulation of "intervening" opportunities (Reference 26) introduces "inertia" effects resulting from the alternative opportunities encountered. Research on geographic and social mobility has resulted in discussion of the "principal of cumulative inertia" as explaining decreasing mobility rates with increasing length of stay in a community, profession or some other state (see Reference 17, 18).

Discussions of distance travelled as a function of distance consider a function that is related to the probability of moving from being a traveller to being a visitor at a distance d from an origin. If one accepts the notion that such a function exists, the claim can be made that an impedance of distance function is of fundamental structural importance in understanding travel behaviour. For example, picture inertia in Wolfe's terms by viewing the decision making process as involving the thought: "If I have gone as far as d, what is my desire to go further?" And given the question, consider the expression:

(1) P(d,ø) = Probability of not going ø units further than d

$$= \frac{\text{\# going at least to d but not to d+ø}}{\text{\# going to d or further than d}}$$

Since the area under the gravity function between d and d + ø "measures" the number of persons who stop, while the area from d to infinity measures the number that go beyond d:

(2) P(d,ø) approx = Døg(d)/ł(g(x)dx)

WHERE the integration is from x=d to infinity and ø is some relatively short distance (e.g. mile or less for visits to major non-urban parks) and g(d) is the distance part of a gravity function that is defined so that the integral in the denominator exists and defines the number of persons (parties, vehicle or

whatever units) travelling beyond a distance d.

By allowing ø to approach zero, and if the limit indicated in Equation 3 exists, the limit as ø approaches zero of the probability of not going at least ø further divided by ø is a function that is an instantaneous measure of the impedance of distance. For this reason the "impedence of distance function" is defined by:

(3) IDF(d) = limit (as ø -> 0) P/ø
= g(d)/ł(g(x)dx)

WHERE the integration is from x=d to infinity.

From the way IDF(d) is defined, it is clearly reasonable to argue that IDF(d) is related to the hesitance felt by a traveller toward going an additional time-distance unit, i.e. it is related to making a decision in marginal terms. It is not unreasonable to propose that IDF(d) is directly related to the marginal utility of continuing on from a given point. So, a decision in absolute terms is a decision in terms of the d's to certain destinations. For example, assume a person sees two physically identical sites at d1 and d2 as available. In absolute terms one visualizes an "economically rational" person as choosing the closer site, or possibly suspects the two sites get visitors from the given origin in the ratio g(d1)/g(d2).

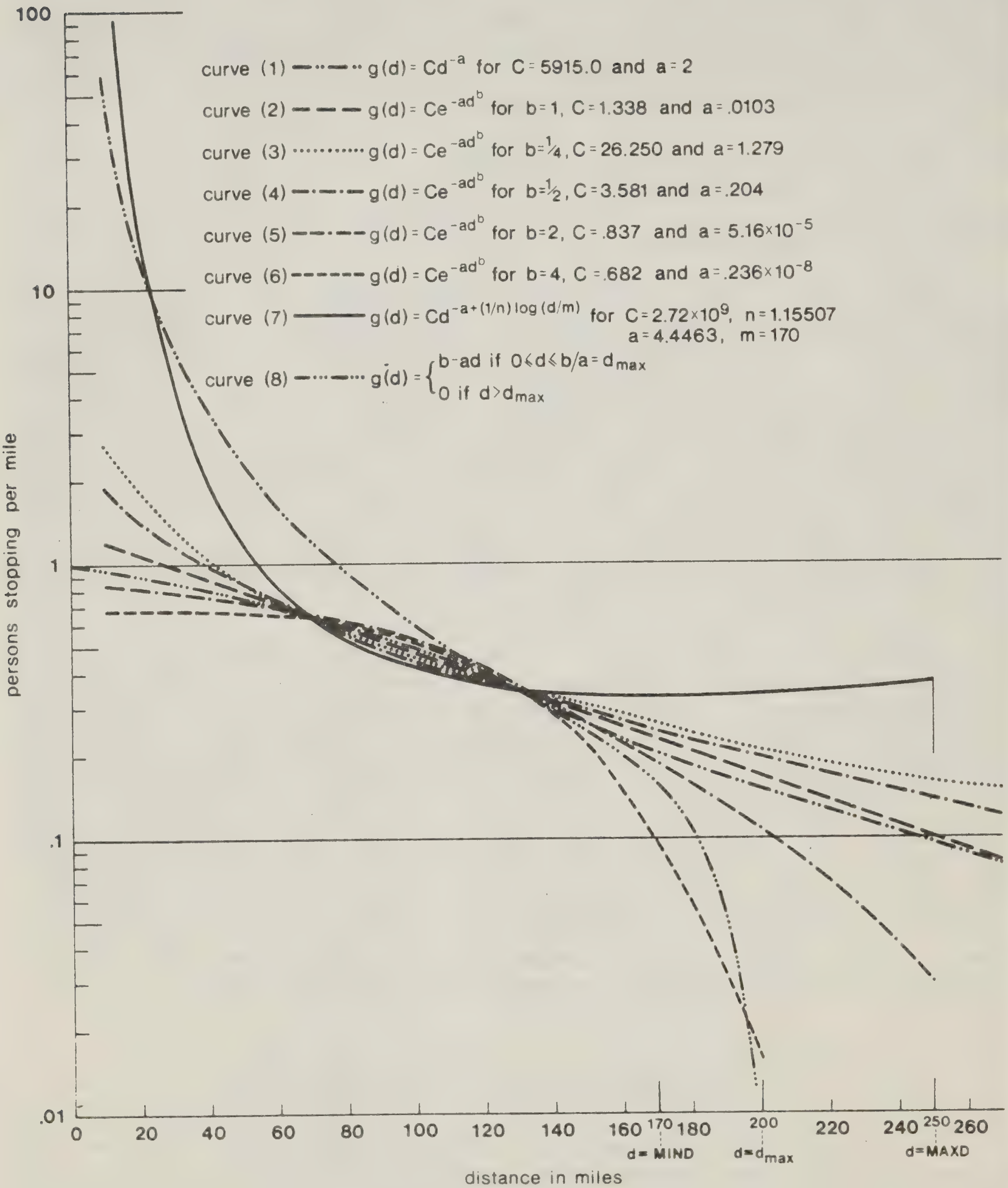
However, given the concepts of "marginal" and "absolute" decision making, it is reasonable to argue that travel decisions involve both a marginal and an absolute component. Single purpose visits, particularly involving routine household functions (e.g. getting groceries) may involve a great deal of absolute "economic rationality" and little of the element, "if I go as far as X, I might as well go to Y". On the other hand sightseeing or vacation travel may be heavily weighted toward decisions based on marginal utility considerations. Wolfe's inertia concept applies primarily to this latter kind of travel. It is fair to say that this paper investigates a "polar" type of travel decisions, namely decisions made in marginal terms.

THE IMPEDANCE OF DISTANCE FUNCTIONS FOR SEVERAL g(d) FUNCTIONS

Although it is readily acknowledged that little is known on how decisions are made by various people for various types of trips, the model just proposed is used to see how a homogeneous group of people might react to distance if(their travel decisions were made in marginal terms and if their g(d) were known(And, since there exists a variety of g(d) functions that could be the correct g(d) function for a group, there are g(d) functions available that may reasonably be considered.

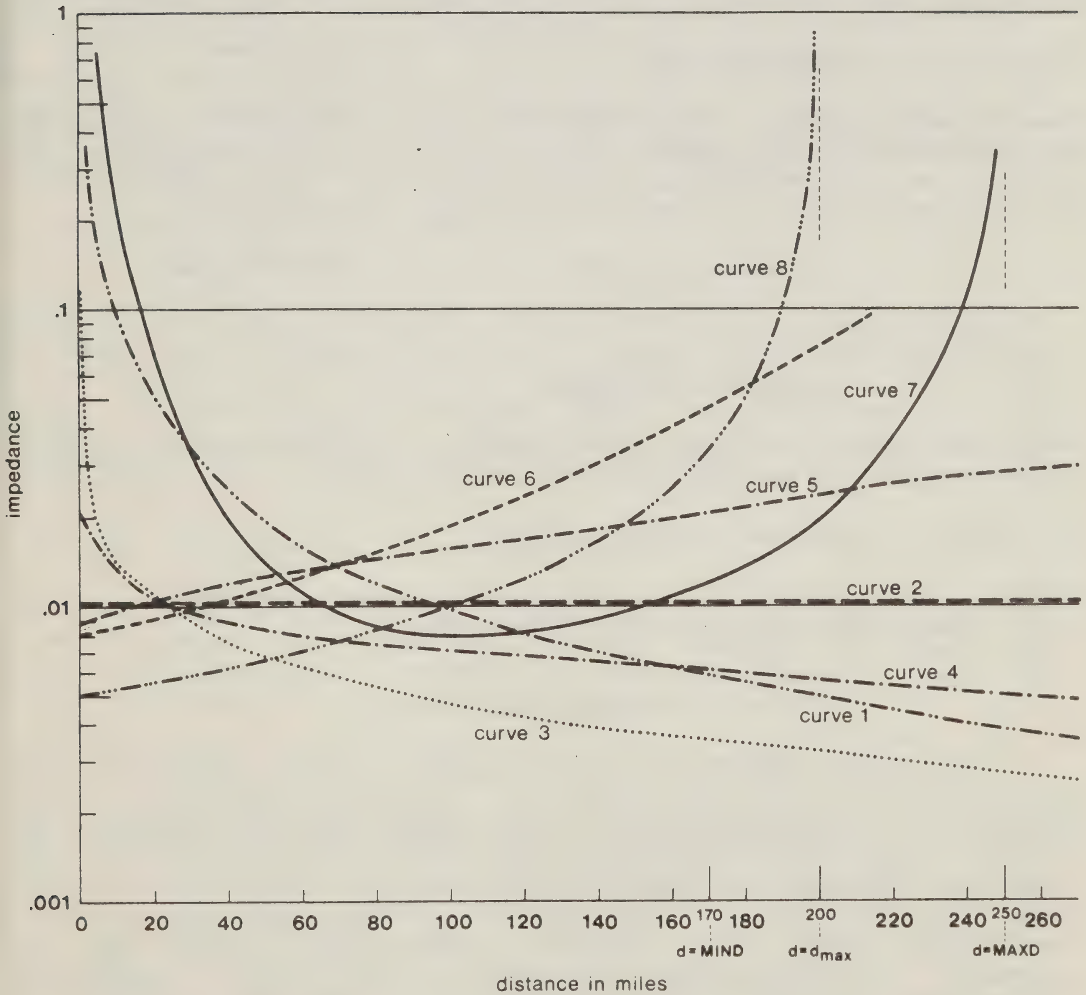
Five functions that have been considered in modelling

Figure 1 **The Distance Component of "Gravity Functions"***



*The parameters of the functions were intentionally selected so that the functions would intersect at 70 miles and 130 miles except for (1) which for a = 2 can be forced only through one point.

Figure 2 **Impedance of Distance Functions for the Functions Given in Figure 1**



travel behaviour are defined by Equations 4 through 8 and these functions are shown in Figure 1. The "standard" gravity model is based on:

(4) g(d) = Cd**-a

Unpublished research carried on as part of the Canadian Outdoor Recreation Demand (CORD) Study suggested:

(5) g(d) = Cd**(-ad)

which is subsumed under the U.S. Corps of Engineers' equations for reservoirs which is defined by the form:

(6) g(d) = C exp(-ad**b)

Beaman and Leicester (see Reference 1) presented a variety of examples using linear functions to give potentials to visit. The following expression, while not the general case, is representative of the linear class of functions.

$$g(d) = \begin{cases} b-ad; \; b>0; a>0 \text{ and } 0 \le d \le b/a=d(max) \\ \\ \text{zero otherwise} \end{cases}$$

Finally, the Wolfe "inertia" function (see Reference 32) is considered. It may be written as follows:

(8) g(d) = Cd**(-a+(1/n) log(d/m))

WHERE a is a "usual" gravitational distance exponent
and n and m are other constants.

CONJECTURES

The five forms of g(d) introduced above embody a wide variety of implications about the effect of distance on the decision to travel beyond a point which has been reached. So before explicitly examining the IDF(d) functions for the equations introduced, some conjectures on the nature of the "impedance functions" expressing the "marginal utility" of additional travel are valuable because they illustrate how confused a researcher's impressions of what a person's reaction to distance may be when based on knowledge of g(d) rather than IDF(d).

Conjecture 1. The linear form given by Equation 7 arises because of a constant force (impedance) acting in opposition to further travel.

Conjecture 2. An exponential form of g(d) implies

an impedance related to a force to stop that increases with distance. (See Equation 5.)

Conjecture 3. The C/(d**a) function implies that the further one has gone, the less likely one is to go another mile.

INTERPRETATION OF THE IDF(d)'s

The relation presented in Equation 3 may be used to determine the actual form of IDF(d) for the five g(d)'s introduced above. It is recognized that the way that IDF(d) is defined means it is similar to the force of mortality function considered in demography but this fact is not considered or exploited in the paper. So, using Equation 3 the IDF(d)'s were derived and are shown in Figure 2. The "traditional" gravity function has an IDF(d):

$$(9)\quad IDF(d) = (Cd^{-a})/(Cd^{(1-a)}) = (a-1)/d$$

where it must be recognized that a must be greater than one. In fact, ad hoc regressions that suggest that a is less than or equal to one implicitly suggests) that an (infinite) number of visitors go further than any distance one may state - a condition researchers should consider if regression gives an a less than or equal to one. In the second case:

$$(10)\quad IDF(d) = (C^{-ad})/(Ce^{-ad}/a) = a$$

which is Equation 11 with b equal to 1. The IDF(d) of the generalization of Equation 10 is different than the preceding since the integral in its denominator cannot be written in terms of a "simple" familiar function.

$$(11)\quad IDF(d) = C \exp(-ad)^{b} \,/\, (\int C \exp(-ad)^{b}\, dx)$$

WHERE the integration is from x=d to infinity; and if b = 2, the integral can be evaluated using tables for the normal distribution and where, if b is greater than zero, tables for the incomplete Gamma function allow evaluation of the function. The IDF(d)'s were calculated using tables prepared for use in statistical work with the Pearson Type 3 distribution (see Reference 21). Specifically the integral:

$$\int (\exp[ax]^{b}\, dx)$$

may be transformed to a usual Gamma function form using Y = ax**b. In retrospect, it seems clear that IDF(d)'s could have been determined most easily if available Gamma Function values (integrals 0 to infinity) had been used with numerical routines to decrease them appropriately to get the

values of the integrals of g(d) for increasingly larger values of d.
The IDF(d) for the "linear" g(x), takes a simple form:

(12) IDF(d) = (b-ad)/(.5a(d-d(max))^2)

where the denominator is readily recognized as the area of the triangle defined by a vertical line at some distance d on the x-axis, the x-axis and the line defined by Equation 7.

Strangely enough Equation 8 is of such a form that for m greater than one and n greater than zero (as Wolfe suggests they should be, so he gets his inertia effect) the area under the curve from d to infinity is "infinite". So, to have a usable function, a maximum distance to be travelled must be stated (e.g. 250 miles as in Figure 1) and then it is reasonable to write the following:

(13) IDF(d) = Cd**(-a+(1/n) log(d/m))/ł(g(x)dx)

WHERE the integration is from x=d to 250 miles.
This must be evaluated by numerical methods for different values of a, n, and m.

The reader should note here that a variety of problems related to the existence of certain integrals have been ignored because it is not the object of this paper to present a comprehensive treatment of mathematical problems. However, it is possible to use Lebesque-Stieltjes' integration to associate a measure with the point d equals zero so it becomes plausible to write of (as Wolfe does) start-up inertia. In such a formulation an IDF(d) can still be considered to apply when d is greater than zero.

One particular point should be noted regarding Wolfe's function because Equation 8 may be written as below:

(14) g(d) = Cd**-A d**(b(log(d)))

where b = 1/n and where

(15) A = a + (l/n) log(m)

Wolfe should compare his inertia function with a gravity function with d**(-A) rather than d**(-a) as he does in his paper. When viewed this way, one sees that the inertia component of his function is expressed by the b(log(d)) part of the exponent of the distance part of his gravity function. A number of other points may also be noted:

1. Wolfe's function is not the only function considered for which impedance decreases as distance increases.
2. The b(log(d)) component of the Wolfe function does initially serve to introduce a larger decrease in impedance than for a corresponding

d**(-a) function.

3. At some arbitrary point, impedance begins to increase and then subsequently becomes infinite in a discontinuous and arbitrary way (e.g. as opposed to the linear form in which impedance becomes infinite but in a continuous and "understandable" way).
4. The Wolfe inertia function might as well be written as Cd**(-A+b(log(d))) since the m is only a parameter that should be absorbed in the gravity function, because not both m and a can be estimated in a regression (since when A and b are determined, a and m are not uniquely determined by Equation 15).

Given the above points, it is fair to suggest that Wolfe's function involves an arbitrary and ad hoc correction to the usual distance part of a gravity function (d**(-a)): as Wolfe suggests, it is a first correction.

As may have been suspected, conjectures on the kind of impedance function that would be associated with a given gravity function were constructed so that all conjectures present an incorrect view. The linear "gravity function" involves a situation where the force to stop increases with distance. In fact, as one approaches the point dmax equals b/a beyond which people do not go, the force function approaches infinity (see Curve 8, Figures 1 and 2). The exponential function considered does not suggest that each new mile one faces is viewed as offering a greater (or lesser) impedance than the last mile. Because of g(d) being the exponential "gravity function", IDF(d) equals a constant; it implies that every new mile is "like" the last one (see Curve 2 of Figures 1 and 2). Regarding the third conjecture, the distance part of the traditional gravity function C/d**(a) does not imply that each new mile presents a greater impedance than the last. The IDF(d) function for 1/d**(a), as shown by Curve 1 in Figure 2, is a function decreasing from very large values near zero to approach zero as d becomes large: each new mile looks easier than the last and at large distances, each new mile presents almost no resistance to further travel compared to the early miles travelled.

As noted earlier, the equation used by the Corps of Engineers is a generalization of the simple exponential form in the way shown below:

C**(-ad) = C exp(-ad**b)   if b = 1

The Corps' function is particularly interesting because its IDF(d) function changes to have three types of shapes:

1. For b less than one it has the form shown by Curves 3 and 4 of Figure 1.
2. For b equals one it has the form given by Curve 2 of Figure 1.

3. For b greater than 1 it has the form given by 5 and 6 of Figure 1.

Thus, when the IDF(d) function for the Corps of Engineers' function (see Equations 11 and 14) is considered, three forms of the curve must be recognized. Firstly, if b is less than one, it is seen from Figure 2 that IDF(d)'s similar in shape to the one for d**(-a) are obtained. If the b in the Corps' equation is one, the equation becomes the simple exponential C**-ad for which the impedance function is a constant, as already noted. Finally, if b is greater than one, the IDF(d) function is similar in shape to the impedance function of the linear form of the distance part of a gravity function. As mentioned above, the impedance function for the linear form goes to infinity as distance approaches a maximum distance, dmax, that people travel according to the "linear gravity function". In this regard, the Corps' IDF(d) function, for b greater than one, does not go to infinity, for a finite d, but Figure 2 does show that for b equals 4, IDF(d) "takes off for infinity" very rapidly.

The IDF(d) for Wolfe's "inertia" gravity function is unique among the functions considered here because of its shape. When MAXD is defined as 250, as it is for the Wolfe function shown in Figure 1, the IDF(d) function, Curve 7 shown in Figure 2, drops initially showing a decreasing perceived impedance of distance as distances increases: in Wolfe's terms, an inertia to continue to travel is built up. But, as suggested by the IDF(d) function, ultimately the impedance begins to increase and then rapidly goes to infinity (e.g. in the example at MAXD = 250 miles).

In Wolfe's "inertia" gravity function, (if something is not plausible,) it is the form of the g(d) function. If the parameters of Wolfe's funciton are such that a minimum of g(d) occurs (in Figure 1 the minimum is at MIND = 170 miles), there is a point, the minimum of g(d), beyond which increasing numbers of people stop at each mile up to an abrupt boundary beyond which there are no trips. But, unless there is really some physical boundary to be considered in a particular problem, it is reasonable to suggest that no such abrupt discontinuity in g(d) should occur. In this regard, Wolfe's function might better be defined by:

$$g(d) = Cd**(-a+be**\{(-.5)((d-u)/s)^2\})$$

SUMMARY

From the curves presented in Figure 2, one notes that there are IDF(d)'s that (1) increase, (2) decrease, (3) are constant, and (4) both increase and decrease. The variety of shapes of IDF(d)'s shown in Figure 2 was certainly not expected by the author. Possibly, the most unexpected results found, however, relate to the fact that not all IDF(d)'s become infinite, showing that at least beyond (some

distance) further travel becomes less desirable in the sense that the next mile offers more resistance than the last - each has higher impedance than the last. In fact, as already cited twice, as well as having an IDF(d) that is constant, functions commonly used in modelling were seen to have impedance functions that approached zero as distance travelled increased. One may note that decreasing impedance suggests that the fact that g(d) and the integral of g(d) from d to infinity both approach zero does not imply the increasing disutility of travel. Rather, the fact that some IDF(d)'s approach zero as d approaches infinity may be taken to reflect the gradual filtering off of people from a finite universe, even though the impedence to further travel continues to decrease.

CONCLUSION

In eliciting an intuitive feeling for his inertia model, Wolfe uses such phrases as: 'In the present note a suggestion is offered for one of these deficiencies - the unresponsiveness of the gravity model to the effect that distance itself has upon the perception of distance.' '...When trips are very short, the friction of distance is negligible. The number of short trips, however, may be smaller than expected because a great many people may not wish to make a trip of any length, however short; their starting-up inertia, as it were, is too great to overcome.' 'At the opposite extreme, one might hypothesize that, among the minority of people who indulge in lengthy trips, a still smaller minority find travel itself so stimulating that the further they go, the further they want to go.'

These statements imply that certain travel decisions are made in marginal terms; in terms of one's reaction to each additional timedistance unit to be travelled (in a manner implied by the IDF(d) function).

The point in recognizing marginal or some other decision making is recognizing that the most prominent lack in discussions employing gravity models is an inadequate behavioural basis for the gravity function introduced. However, this is not to say literature in which behavioural considerations play a role is nonexistent. But, for example, one should not consider Wilson's "Interpretation of Terms Section" of his book (see Reference 31) as the point at which behaviour is introduced into the entropy-transport model. Human behaviour in so far as it is relevant was introduced as implicit in the entropy framework. It is interesting to note Simon's discussion of learning theory models (see Reference 25) where he shows that a theoretically derived equation, which is the case for Wilson's gravity model equation, may be consistent with a number of drastically different behavioural theories. One may also see Cesario (see Reference 7) where he discusses why one of Wilson's more unrealistic assumptions may be relaxed to be more realistic without affecting the model one

would use to explain travel behaviour.

From a theoretical perspective the significance of this note is clearly considered to lie in its focus on the behavioural significance of the IDF(d) function. The author frankly was surprised by the variety of IDF(d) functions resulting from the consideration of g(d)'s which are so similar over the range of d's often considered. (See Note at end of text.) However, when the significance of IDF(d) is recognized, research may be designed to allow more adequate definition of IDF(d) and thus, g(d).

From a broader perspective it is hoped that this discussion of marginal decision making will prompt research on the "mix" of marginal and absolute elements in various travel decisions. Discussion and research are needed because, although formulas resulting in good aggregate predictions of trip distribution are valuable for certain applications, manipulation of these formulas without asking why they work is not social science research. Social science research must ultimately relate accepted formulas that predict behaviour to fundamental social, psychological and, possibly, biological processes.

Note: The similarity of different g(d)'s implies that the choice of a given g(d) on the basis of R^2 or another criterion would involve a high probability of an incorrect choice (of Type 2 error). This should be recognized in evaluating the significance of results by Wilkinson (see Reference 30). Actually, any of the gravity functions considered here deviate from d**(-a) in such a way that in Wilkinson's terms an inertia effect may be found. Also, one should recognize that Wilkinson is dealing with Wolfe's function, which suffers from the other problem already noted.

The author believes that Wilkinson was estimating parameters that could not be uniquely estimated without making unwarranted assumptions. In fact, Wilkinson's introduction of m = 1/8 into his model was not based on objective observation of visitor behaviour. Only when m is determined experimentally should it be regarded as anything but an arbitrary and ad hoc correction to a. On this matter, one may also see that points made about Equation 15 imply that there are an infinite number of parameter sets, one for each m (e.g., m equals 1/8, 1/4, 1/2, 1.0, 2.0, etc.) that give the same explained sum of squares in the kind of regression that Wilkinson carried out - thus his parameterized model is not really based on scientific observation.

PRACTICAL APPLICATIONS OF CLUSTER ANALYSIS

J. Beaman and S. Lindsay

ABSTRACT

This paper presents different ways cluster analysis results may be used by planners and decision makers. It gives hypothetical results for cluster analysis of park user surveys and for national household surveys. These examples are discussed in terms of: 1) how clustering results can be used in considering the equity with which opportunities to participate in activities are provided; 2) how cluster analysis results should be important in the prediction of behaviour; and 3) how cluster analysis results are relevant to futures research in ways not treated by other researchers.

The conclusion is reached that though practical applications of cluster anlysis have not yet taken place, the technique holds great promise for the future.

PURPOSE

The purpose of these notes is to present to planners and decision makers some practical implications of results that can be obtained using cluster analysis.

INTRODUCTION

This paper concentrates on presenting different ways cluster analysis results may be used by planners and decision makers. Burdge and Field (see Reference 4) have cited the need for a cluster analysis approach to the processing of participation data. Tatham and Darnoff's work on cluster analysis (see Reference 27) deals with some of the issues presented here. Their work is of particular relevance for planning implications. Notions on equity, however, are not developed in quite the same way as in the present paper. Their discussion does not deal with prediction of behaviour and futures research in a way that is similar to the perspective endorsed here. A paper on the methodology of cluster analysis by Romsa et al. has already been received by Parks Canada and some results of Romsa's methodological investigation have been published. Specifically, it is in the Journal of Leisure Research (see Reference 22) that Romsa and his colleagues at the University of Windsor have reported on the use of cluster

FIGURE I
HYPOTHETICAL CLUSTER
ANALYSIS RESULTS FOR A PARK USER ENTRANCE OR
EXIT SURVEY ACTIVITY INFORMATION

ACTIVITY

Cluster #	Activity / Person #	INCOMPATIBLE		HIGHLY COMPATIBLE
		1 2 . . . N	N+1 . . . M	M+1 . . . Z-1 Z
1	(10% of People)*		**	
2	(20% of People)			
3	(20% of People)			
4	(20% of People)			
5	(20% of People)			
6	(10% of People)			

* Person #'s are not given, but one could consider that say persons 1, 8, 18 etc. are in cluster 1.

** indicates the primary activities of importance in defining the cluster indicated.

analysis for deriving activity packages from the Canadian Outdoor Recreation Demand (CORD) Study National Survey Information. Given Romsa's methodological effort and given the Burdge and Field and Tatham and Darnoff general discussions, a very practical discussion is now required concerning the ways in which Romsa's results or the results that could be arrived at by others, can be used by planners and decision makers.

Since there is a difference between the kind of cluster analysis carried out by Romsa and his colleagues, and the kind of work that has sometimes been called cluster analysis by other researchers, the reader should look carefully at the example presented in the next section in order to understand the kind of cluster analysis referred to. Briefly, the cluster analysis approach discussed here does not look at intercorrelations between activities, but rather clustering refers to a relation defined by individuals participating in similar collections of activities: clustering is of individuals on the basis of activities in which they participate, rather than on any intercorrelation between activities over some collection of people (see Figure 1).

Concern is not with people grouping themselves in the sociological sense of forming social groups in which there is interaction; at least this is not necessarily the case. Here, grouping refers to people being in collectivities; people are indicated to be members of particular collectivities defined by participation in a certain set of activities. The set of activities that is related to a collectivity is said to be or define the activity package for the collectivity. In the following discussion the existence of collectivities defined on the basis of particular people participating in a particular collection of activities defined by their "activity packages" is accepted.

THE USE OF CLUSTER ANALYSIS WITH PARK USERS SURVEY INFORMATION TO OBTAIN RESULTS THAT MAY BE OF USE TO PLANNERS

One of the problems that arises in trying to understand the results prepared from park user surveys data on activities participated in is (1) the results presented rarely reflect the total loading of facilities and (2) the results, e.g. tables prepared from raw data, do not give a clear picture of the multi-faceted participation characteristics of the users of facilities. (Assume here that the user information is collected as part of an entrance or exit survey.) In reality one of the major dimensions of analysis concerns may be the mix of activities in which people participate. Information on the collection of activities in which an individual participates and on the characteristics of participants simply loses the dimension of activity mix when presented on an activity by activity

basis. Even cross-tabulations of activity against activity only give a very limited insight into individuals' activity mixes.

Participation analysis that goes beyond a simple analysis of facility loading requires a technique that reflects the interrelationships between the activities in which individuals participate. The use of factor analysis to examine intercorrelations defined by people's participation in a number of activities violates the basic assumption of defining "activity packages" (see the Appendix). Rather, one must adopt a true cluster analysis technique that will break the user population into relatively homogeneous groups on the basis of those activities in which individuals participate.

For some people the preceding discussion may be rather abstract and even appear obtuse. So, assume that three types of activities are provided in a park: (1) activities which are not compatible with the theme or general purpose of the park; (2) other activities that are not offensive to the purpose of the park but not exactly in line with its theme; and (3) activities that are consistent with the purpose of the park. If a cluster analysis of park user survey data on the basis of the activities in which visitors participate were carried out for a given park, then one could see how people's participation is divided among the sets of activities just noted.

Figure 1 presents hypothetical results of a cluster analysis of summer activities in a given park, suggesting that there are six clusters and thus six types of park visitors. The figure shows that ten percent of visitors show an interest both in incompatible activities and in activities that do not tie strongly to the theme of the park. The third group indicated is not involved, to any large extent, either in incompatible or in highly compatible activities. The fourth cluster of people noted are those that present an extremely problematic pattern of clustering by participating in both incompatible and highly compatible activities. The planner might wish to serve these visitors by moving incompatible activities out of the park (to be supplied by the private sector) while leaving the highly compatible activities in the park.

Finally, the last two clusters indicated in the figure involve respectively 20 and 10 percent of the park visitors. These are the clusters made up of people whose participation focuses on highly compatible activities. However, Cluster 5 involves a high level of participation both in activities that are not highly related to the park theme (but not incompatible), and in incompatible activities.

One should note that while Figure 1 may clarify how the results of a cluster analysis of park visitor survey data might be of use to a planner, the figure oversimplifies the kind of clustering pattern that might be expected in a cluster analysis. This oversimplified clustering pattern results in an "obvious" interpretation of the results, which would rarely occur. Certain sets of activities containing

some highly compatible activities and some activities of the other two types may turn out to define activity packages for people. The activity package just alluded to may have few activities in common with another activity package that also involves activities that run from incompatible to highly compatible. The existence of two clusters that both involve incompatible and highly compatible activities, may reflect an orientation of some people toward physically demanding activities and others toward passive activities when both incompatible activities and compatible activities are considered.

In terms of the example just cited, one can see that a dimension of clustering not suggested by the figure may be relevant for consideration in planning. However, one may wish to ignore the active-passive split and, for planning analysis, combine clusters to match the pattern shown in Figure 1 by combining clusters that are identified by a computer analysis of park user survey data.

CLUSTER ANALYSIS OF HOUSEHOLD SURVEY INFORMATION - AREAS OF CONCERN TO PLANNERS

A Perspective

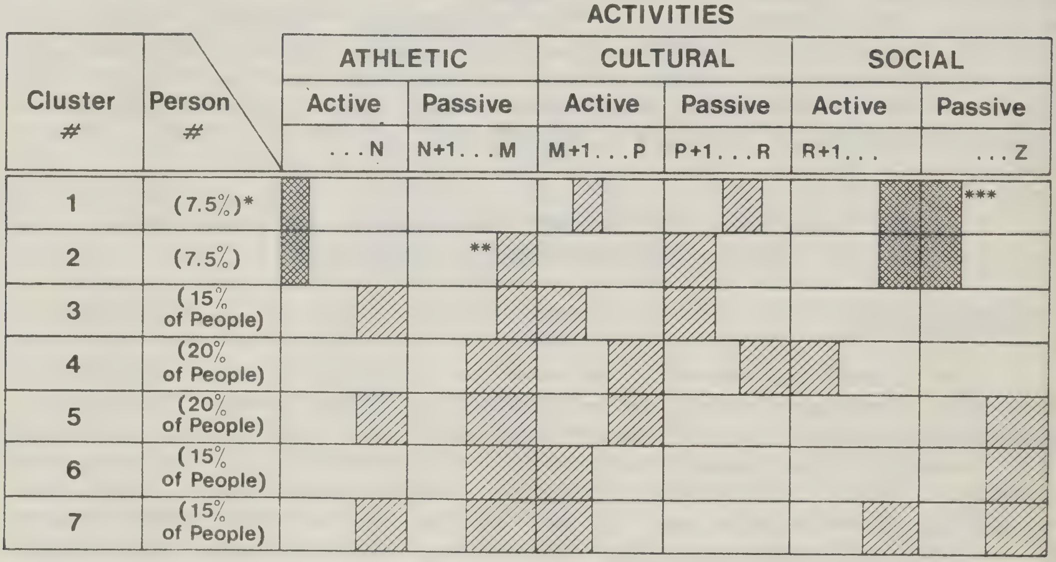
The planning considerations to which the development of activity packages from data collected from people at their homes is claimed to be important, are (a) the equity factor; (b) planning for specific areas or population; (c) future research; and (d) predictions of behaviour. This data can relate to participation in activities at a particular park or to participation in all recreation activities. This paper is working in the latter context - data collected on participation patterns at any park, private facility or at home.

The reader is asked to refer to Figure 2, which is very similar to Figure 1, except that the focus of attention is not on activities that take place in a given park but rather, on a set of activities which for some reason was chosen to be considered in a National or Regional Survey. Thus, in contrast to the way activities are divided in Figure 1, the list of activities dealt with may reasonably be broken into active or passive; into social, cultural or athletic; or into whatever classification is appropriate for the policy related research and/or planning of the Administration Unit involved in a given analysis.

Equity

Cluster analysis has value in considering equity because by breaking up the population according to the activity packages in which they participate, one can see the equity with which activities are provided to various collectivities of people. It is not suggested that all the activities listed in a survey should be provided in such a

FIGURE II
HYPOTHETICAL CLUSTER ANALYSIS
RESULTS FOR AN ANALYSIS OF
NATIONAL SURVEY DATA



* Person #'s are not given, but one could consider that, say, persons 1, 8, 18, etc., are in Cluster 1.

** [hatched] and/or [dark grey] indicates the primary activities of importance in defining the cluster indicated.

*** In the text reference is made to tent camping, trailer camping, fishing, hunting and driving for pleasure. Participation in these activities is indicated by the dark grey areas. Tent camping, fishing and hunting are assumed to be ATHLETIC-ACTIVE, so to distinguish participation in these activities the dark grey area appears under ATHLETIC-ACTIVE for Clusters 1 and 2.

way that each collectivity associated with an activity package receives the same dollar input from a given agency's Parks and Recreation Expenditures (receiving the same dollar input is not even necessarily possible); there is no suggestion that equity is reflected if planning involves allocating money to activities so that some kind of balance is kept in the money benefits that people with various activity packages "receive". However, if one is placing money into a number of activities, then one can look at activity packages for the collectivities into which a population is divided and see in which packages the activities just noted occur and, in which packages they do not: one can see what proportion of the people are being served by a given set of activities and in some sense how.

If the activities noted in the last paragraph occur in only two activity packages involving 15 percent of the population (see Figure 2, Clusters 1 and 2 marked by cross hatched) and these are the only activities into which government puts money, then there is obviously some inequity. But if one government agency puts money into supporting tent camping, trailer camping, fishing, hunting, and driving for pleasure while there are other activities into which other government agencies put money or if, for example, provincial responsibility is related to athletic activities and the federal agency is examining the activities into which they are putting money, then inequities that may be reflected by supplying facilities for activities in which only 15 percent of the population participate may well be irrelevant to the national level planner responsible for planning provision of specific facilities.

The point is that, by defining groups of people according to the activities in which they participate, one gets a clear and multi-dimensional idea of who is receiving what support when money is put into several activities or into a large number of activities. Thus, when cluster analysis results that define activity packages are available, one avoids the error of thinking that because 15 percent of the people in a population participate in one activity (e.g. an activity common to both Clusters 1 and 2) and 22.5 percent participate in another (an activity common to both Clusters 2 and 3), then monetary input in the two activities services 37.5 (22.5 percent plus 15 percent) percent of the population. (Actually, in the example cited, 30 percent, that is 7.5 percent plus 7.5 percent plus 15 percent, of the population is served.) The author maintains that this kind of fallacy permeates the thinking of many officials who believe that planning for activities should be done on the basis of the total man-days of participation in each activity or on the basis of the proportion of the population participating in each of a number of activities. But there is a need to distinguish between planning based on a fallacious use of information, and allocation of resources where equity considerations may be relevant from a geographical distribution of expenditure but not from some

other perspective.

Given the points made above, the author claims that when cluster analysis results are available for a given city, it can be abundantly clear if the cluster analysis results indicate that the recreation plan for the city endorses or results in a physically active minority of the people receiving drastically disproportionate amounts of recreation dollars, in comparison to those people who may have activity packages which contain relatively few, say, passive activities. (Romsa, see Reference 22, presents activity packages for Quebec that show the possibility that most recreation dollars go to a few people.)

Planning Implications

Planning implications that can be derived from cluster analysis that do not relate to equity considerations (a policy consideration) may be understood easily, given the preceding discussion. If a population can be broken into the kind of collectivities just described (collectivities based on activity packages), then the population has been broken into natural units. This is because the various activities in an activity package may inter-relate. There may be a trade-off between activities (see Reference 3, 5, 11, 15, 22) or some other relationship (see Reference 1). An understanding of such relationships between activities, as well as a knowledge of the sizes of those collectivities that have an activity package making them a market for a facility package, allow the planner to recognize facility packages that are wanted by various segments of the population. Also there is the possibility that the planner can recognize the kind of facility or activity "deficiencies" that may reasonably be left when one activity is allowed to substitute for another (see Reference 5).

With the activity packages for the various "groups" in the population in mind, the planner can begin to see why large segments of a population will not participate in certain facilities if a certain set of activities is provided. Given such information, planners can inform politicians of the "real" significance of a situation. When a political ruling (policy) on what will or will not be provided is to be examined, the planner who has cluster analysis results relevant to be given policy, can give the politician a clearer idea of what he is really asking about and why, with regard to a given policy, than is usually possible without cluster analysis results. The important point is that the planner who has cluster analysis results can inform the politician and/or manager of the consequences of given actions in a much more intelligent way than can be done when the only figures that can be provided are figures that show that some people do not participate in one activity or another. Cluster analysis thus allows the planner to better understand the structuring of behaviour. By allowing a better understanding of the structuring of behaviour, cluster analysis makes possible a realistic and

comprehensive discussion of planning options. Thus politicians and/or managers/decision makers can make better decisions regarding facility provision than are usually made today (at least the potential is there).

Futures Research

The preceding section could have started with the statement that: to say people behave in such a way as to define activity packages is almost a tautology. The import of the assertion that people's participation in activities defines activity packages really becomes clear when one recognizes that for purposes of futures research, activities do not have a future. Rather, activity packages have a future. It is the people living today and having similar patterns of behaviour who, as they move into the future, may be expected to modify their behaviour so that activity packages shift as new activities shift into activity packages, or some activities shift out of some or all activitiy packages.

The basic fallacy in much current recreation-leisure oriented futures research is that it approaches making projections into the future by projecting the future of activities, activity-by-activity: researchers approach the future of an activity by asking what is going to happen to this activity and, in doing so, fail to recognize that it is not the activity that goes into the future and behaves in some way. It is people who, by living from day to day and year to year, go into the future and either change or maintain their behaviour and attitudes. Thus, cluster analysis of participation data results in appropriate units, the activity package and the collectivities associated with activity packages, with which to confront delphi panels when they are asked to make predictions of the future.

In other words, it is claimed that the task of a delphi panel should be to make projections for activity packages (1) in terms of the number of people in the population that will be in given collectivities associated with given activity packages and (2) make projections that indicate what activities may drop from a package, and what new activities may be expected in the package. They must also suggest totally new kinds of activity packages that may arise. Then the panel must put the results of projections for all activity packages (new or existing) together to get an activity-by-activity perspective for the future, if for some reason there is concern with having an activity-by-activity perspective.

The simple activity-by-activity approach to projection confuses the issue of what is really happening over time by removing the insight that may be gained in recognizing a structuring of participation in activities in our society. For this reason, in order to make reasonable projections, one needs to recognize the fact that certain collectivities can be defined and used in making futuristic projections.

Predicting Behaviour

Finally, a consideration related to the points made above is that cluster analysis offers insight into behaviour that is important in predicting behaviour. The predictions that one needs to make in planning or policy evaluation may not be predictions of the future. Examination of the characteristics of a population in an area where survey results are not available may indicate that people are such that certain activity packages may be expected to exist if certain facilities are created (i.e. if certain policies are followed). Specifically, until we understand the behaviour of people in terms of activity packages, there will be a tendency to treat the prediction of behaviour on the basis of individual activities regardless of whether a large array of alternative activities is supplied.

At present it does not seem clear that there is a methodology by which cluster analysis results can be used to make predictions of what will happen in terms of people's participation in certain activities in a given area under various policy options. Nevertheless, cluster analysis is the only methodology that defines the kind of activity packages that are here argued to be of importance. Thus, the results of cluster analysis offer information that is of value in making policy-related predictions and therefore it is presently the only methodological tool known to the author that has any promise of improving our productive ability by increasing our understanding of activity substitutability and complementarity.

CONCLUSION

The discussion in the preceding sections has presented considerations related to a number of practical applications of cluster analysis. Though it would be desirable if all of these areas of application could be explained in terms of practical examples of what has actually been done, the practical application of cluster analysis to define activity packages to be used in the ways described has simply not taken place. In fact, it is the purpose of this paper to prompt practical planning work using cluster analysis results by setting down the suggestions and guidelines noted here.

APPENDIX

To understand why factor analysis should not be used to derive "activity clusters" one need only understand a few basic considerations. Factor analysis should be used only when the data for analysis are considered to have underlying dimensions common to all people (recall the early studies on single or multiple dimensions of intelligence) or when any sub-group of the population selected for analysis has the

same dimensions as the population as a whole. Data should not be considered as having an internal structure such as the one suggested by the clustering illustrated in Figure 1. Figure 1 suggests that the people in a community or nation (as suggested by Romsa's research on Canada - Quebec results reported in the Journal of Leisure Research, see Reference 22) may be broken up into collectivities in which individuals participate.

Each one of the collectivities derived by cluster analysis is characterized by the intercorrelations among the activities which define the "cluster of people" that have the activity package (defined by the activities in which people in a given collectivity participate).

Given that a number of collectivities encompass all the activity packages of a community, it may be asked what the intercorrelations of people's participation in activities, usually processed in factor analysis, reveal. Actually, the intercorrelations tell one in large part about the relative sizes of various collectivities in a population rather than giving any information about the individual collectivities per se. If certain sub-groups of the population of a city are selected for analysis, one does not get the same factor structure for the population as a whole unless dealing with a very particular kind of sample designed to be representative of the city as a whole: when a population is sub-divided on the basis of age, sex, education, income and other variables, the relative balance between collectivities changes in various sub-groups (this is confirmed by cluster profiles derived by Romsa, see Reference 22, and results presented in Currie, see Reference 9).

The point being stressed here is that factor analysis is the most appropriate tool to use in looking for structure in data only when (see Reference 14, 16) the invariance of factor structure for sub-groups in the population condition holds. Specifically, if the assumption of invariance of correlations based on people's participation in activities is to hold, the population that is being subjected to a factor analysis must not be structured with respect to its participation in outdoor recreation activities. When such a structuring exists, factor analysis is not an appropriate technique for learning something about the structuring of participants in the population of concern.

As well as the fairly general theoretical considerations just noted, a more detailed critique of the factor analysis "clustering technique" could be based on reference to a number of points. In particular, the instability (loose definition) of structures defined by varimax rotations or other factor rotation algorithms is one point that should be considered. Along this line, it can be noted that algorithms have been developed to relate factor structures derived on one set of data with factor structures derived on another set of data. However, it has also been shown that because of the nature of the transformations involved, factor structures from two sets of data can often be related even if there is little relationship.

COMMENTS ON THE PAPER "THE SUBSTITUTABILITY CONCEPT: IMPLICATIONS FOR RECREATION RESEARCH AND MANAGEMENT" BY HENDEE AND BURDGE

J. Beaman

ABSTRACT

In this article the author accepts the importance of the Hendee & Burdge paper but cites a number of important ideas related to substitutability that they did not include in their paper. In particular a concern is expressed that the Hendee & Burdge article could lead to factor anlaysis being used to study substitutability when or in ways that it should not be used. Specific reasons are given that R-mode factor analysis should not be used to study substitutability. It is stressed that there has not been sufficient account of behaviour being a function of the factors inherent in the clustering of individuals according to their activity packages and it is claimed that such clustering of individuals should be studied by true cluster anlaysis techniques.

One could say that "the comments" provide the conclusion that activity groupings defined by R-mode factor analysis do not constitute an appropriately specified unit for use in evaluating user satisfaction or in facilities planning. At some time in the future, true cluster anlaysis results along with other information may provide information on substitutability that will be useful to planners.

The Hendee and Burdge paper is very important because it contains a discussion of concepts that are beginning to play a significant role in recreation research. However, certain important ideas related to substitutability that have been developed in other articles are not mentioned and several of the articles that would have been useful to cite are not readily available. (see Reference 1, 3, 9, 11)

There are, nevertheless, published articles not cited by Hendee and Burdge that deal directly with substitutability. One such article makes the point that when measuring substitutability it is important to distinquish between: (1) the clustering of activities obtained by a factor analysis of the correlations between variables giving frequency of participation in activities and (2) the clustering of individuals on the basis of the activities in which they participate. In a Canadian Outdoor Recreation Demand (CORD) Study Report (see Reference 23), Rousseau

makes the following statement:

> The approach of analysing participation data to find clusters of people who have similar activity patterns may be contrasted with an approach described by Burton and Noad (see Reference 6). This method is applied to 1969 National Survey data in a thesis prepared by Gillespie (Reference 11). In Burton's "clustering approach" correlations between activities are examined without consideration of whether the correlation between activities reflects a clustering of individuals or not.
> Burton (Reference 5) has suggested that correlations between activities reflect trade-offs that can be made in planning. However, the "true" clustering approach used by Romsa et al. (Reference 22) only supports Burton's claims when the correlations observed have the right value for individuals within a cluster. Even when participation in activities is correlated for individuals with the same activity package, two activities may be complementary not substitutable (see Reference 1.)

The Bishop material to which Hendee and Burdge refer under the title "An Empirical Illustration of Substitutability" is an example of the Burton type of substitutability analysis to which the Rousseau article takes exception. Burton's "clusters" are essentially the same as the packages of "interrelated" activities reported by Bishop (Reference 2) and confirmed to be found in other analyses (Reference 24).

An important theme of these notes is that Burton's R-mode factor analysis should not be used to derive activity clusters if these clusters are to reflect substitutable activities. To understand why this thesis is supported, it is necessary to introduce a few basic considerations. Firstly, R-mode factor analysis can be used to recognize linearly "related" variables. The related variables can be recognized by examining factor loadings but the relation only means what it is usually taken to mean when the data have underlying dimensions possessed by all people. One should recall early research on single or multiple dimensions of intelligence. The point is that R-mode factor analysis is most appropriately used to look for the structure in data only when the invariance of a factor structure holds for sub-groups in the population (see Reference 14, 16): any sub-group of the population selected for analysis should have the same dimensions as the whole population.

In practical terms, then, data should not be considered to have an internal structure such as that suggested by Romsa's research on Canada if R-mode factor analysis is to be used to discover related activities. Romsa's Quebec

results (Reference 22), which were not cited by Hendee and Burdge but which did appear in the Journal of Leisure Research (Reference 15), show that Quebec's population may be broken up into collectivities of people on the basis of the activities in which individuals participate, that is, divided into collectivities having different activity packages. Obviously, each collectivity discovered by Romsa is characterized by the intercorrelations between the activities defining that "cluster of people", not by aggregate between activity correlations for "the population".

Yet the wary reader may feel that R-mode factor analysis could be used to get factor scores and that factor scores could be used to find clusters of individuals who have similar scores on the dimensions discovered by the R-mode factor analysis. Many things are possible: one can even learn the same things from R and Q-mode factor analyses. However, one who is familiar with cluster analysis knows that even a Q-mode factor analysis is not a particularly good methodology to discover a structuring of behaviour like that found by Romsa.

A more detailed critique of the use of the factor analysis "clustering of activities technique" to study substitutability can be based on a number of points. (In this connection, it may be noted that algorithms have been developed to relate factor structures.) However, because of the nature of the transformations involved, the factor structures from two sets of data can often be related even if there is little true underlying structural relationship. Possibly of more importance theoretically is the fact that the varimax solution is only one of an infinite number of solutions to "the" factor analysis problem. Why should this solution be singled out as the one in which factor loadings show a person about substitutability? Bishop's work (Reference 2) and comparative articles such as Schmitz-Scherzer et al. (Reference 24) should be evaluated with this point in mind when one is tempted to use the results to point out meaningful collections of activities to be used in planning or policy making.

Given the results of Schmitz-Scherzer et al., the statements just made should not be taken as implying that the R-mode factor analyses do not produce some interesting insights about some things. The concern raised by the preceding paragraphs is that factor analysis of the correlation between variables will almost certainly give a number of incorrect impressions if it is used to understand substitutability. So, it is because of Hendee and Burdge's reference to Bishop's work and their lack of reference to Tatham and Dornoff (Reference 27) and to Romsa's papers (Reference 22) that the preceding discussion is considered particularly important. Hendee and Burdge did not specifically endorse research using R-mode factor analysis to study substitutability but there is the clear possibility that their article could result in such research being started.

Other problems involved in understanding substitutability that were not adequately discussed may be understood by examining specific considerations. In the Beaman and Leicester monograph (Reference 1), a major focus is on breaking a population into socially meaningful collectivities for which clusterings of activities and activity packages related to behaviour can be discussed. They stress the need to recognize collectivities such that when any individual from a given collectivity is in a given circumstance defined by availability of (1) recreation facilities, (2) time, (3) people with whom to participate and (4) mood, the decision made regarding participation in an activity at a given facility will be typical of the decision made by any member of the collectivity. The O'Leary and Field (Reference 19) and other articles cited by Hendee and Burdge clearly indicate that the kind of collectivities to which reference has just been made are defined by social variables in addition to the participation variables studied by Romsa. But Hendee and Burdge do not carry their discussion forward to draw the conclusion that behaviour will be a function of all the factors just noted. Nor do they adequately note that behaviour being a function of the factors noted has important analyses methodology (research) implications. The article implies that substitution depends on (1) with whom, and (2) other socio-economic variables including age. However, this raises few difficulties. One important implication indicating real problems is that supply distribution results in behaviour failing to "mirror" preference. Does substitutability depend on behaviour? Or, does it depend on preference? Regardless, it must be made abundantly clear that until there is recognition of the collectivities within a population that have common activity packages and other common behavioural and social characteristics, and until it is determined how substitution relates to available supply, trade-offs between activities will at best be poorly understood.

An issue raised by the Rousseau quotation included earlier, but not mentioned by Hendee and Burdge, is that substitutable activities must be distinguished from complementary activities. Participation in activities by people with a common activity package may be highly correlated for two reasons. High correlations may reflect the fact that people recognize certain activities as substitutable. Or the activities may be complementary, in which case satisfaction gained from participating in one activity is contingent on participating in the other. This example may be interpreted in a trivial way: vigorous exercise may be satisfying only if the possibility of washing afterwards exists. Are Hendee and Burdge dealing only with substitutability, or are they implicitly concerned also with complementarity?

In conclusion, once one recognizes the importance of distinguishing collectivities within a population which have activity packages defined by a method other than factor analysis, it becomes clear that questions, for example,

about the satisfaction of facility users should be raised on the basis of these collectivities. Activity groupings defined by R-mode factor analysis do not constitute an appropriately specified "unit" for use in evaluating user satisfaction or for use in planning what should be provided. It is with respect to collectivities defined on the basis of similar personal participation "sets" that meaningful planning must take place, and it is with respect to these collectivities that planning options and ramifications of political decisions must be evaluated (see TN 32).

Similarly, the determination of activities for which there are no substitutes is meaningful only in the context of collectivities of people with similar behavioural "sets". In this connection, Romsa's work shows that there exist large numbers of people for whom there are probably no substitutes for the very few activities in which they participate. In contrast, the results obtained by Gillespie using factor analysis, and the same data analysed by Romsa, suggested that there are large numbers of trade-offs that apply to all Canadians. Gillespie (following the Burton framework) confused correlations in the aggregate with those for meaningful collectivities.

In pursuing the important research area reviewed by Hendee and Burdge, it is essential that people not make the kind of mistakes in interpretation just noted or carry out inappropriate analyses. It is because of this fear that these comments have been written, not because of any basic disagreement with Hendee and Burdge on the need to do substitutability studies or on why such studies should be done.

REVIEW

J. Beaman

The most appropriate comment on this chapter appears to be that one should not become overly involved in thinking that TN 14 and 37 have practical implications. The TN on "Distance as a Function of Distance" while clarifying something about how decisions may be made does not dwell on the fact that all the distance functions considered are so close in shape (as can be seen from Figure 1 in the article) that it makes little difference which function is used in a particular modelling effort. One function may be better than another for predicting trips made by people who come from a long distance, but this depends on the type of trip being considered.

Certainly, there appears to be merit in using a function like the exponential function which does not show extremely high use levels when a park is very close to people. However, just because the exponential function does not become infinite when the distance to travel to a park equals zero does not mean it has the appropriate shape to reflect behaviour. It seems to this writer that in fact, as the distance to a park becomes shorter and shorter, after the park is already close the number of recreation trips made into a park would not change very much and this is the case with exponentials and linear "gravity" functions. But selecting the correct distance function is of minor importance compared to other problems in specifying the correct structure in modelling travel flow.

None of the articles in this volume (with the possible exception of TN 20) are explicit about "magnitudes of the problem" associated with different structural difficulties with models. TN 19 and 35 present results which are typical of what is found when one proceeds to use a simulation approach to test how well models are working. The fact that they are not working well is apparent, particularly when one tests the Cesario model (TN 4) or Cheung Day-Use model (TN 1) in this way (see TN 4). If the models were structurally sound an R^2 of .99 rather than the lower R^2 found should be expected. The major reason for the structural problems is not because of errors in the distance function: at least this is indicated by the fact that R^2 changes little when a variety of distance functions are considered. Problems with the way attractivity is measured, with the way alternative factors are considered, with the total structure of models (addition or multiplication etc.) and with the disaggregation of visitors are among the factors cited in this volume that need to be dealt with much more than the esoterics of choosing distance functions to reflect behaviour.

Turning to TN 37, this reviewer can look back to his own 1970 work and there he can find statements that the problem of substitutability is so complicated that it is not

likely that in the near future (1) sufficiently large data sets and R^2) necessary theoretical development will take place to allow one to make effective use of this "property behaviour" in planning. Still, if unclear about the consideration just noted, TN 37 is definitive in pointing out the confusion that presently exists about how substitutability analysis should proceed. Incidentally, cluster analysis results are not simple to interpret and getting them often involves use of mammoth amounts of computer time if a reasonably large number of cases are to be dealt with so that populations can be split into a number of meaningful groups. Regarding the matter of interpretation of clustering results, one should note that the discussion of TN 37 totally ignores the influence of supply on substitutability. One cannot simply move ahead using the methods described in TN 10 to do clustering and then examine clusterings to find out about substitutability. The reasons that activities are substitutes in one place and are not in another relates to the availability of supply. Availability of supply does not simply relate to whether supply exists or does not exist. One must consider levels of supply, its attractivity and programs that encourage or discourage use among certain groups (among other things). From a practical perspective, traditional discussions of substitutability ignore the fact that education is one of the primary mechanisms that can be used to change behaviour. Substitution as it exists presently may relate very much to what is available, but that does not mean that substitution in the future cannot relate very much to how we teach people to respond to different opportunities.

Moving on to TN 32, a primary criticism that may be laid against it is that it should have included practical examples. Since the note was prepared, a practical example of the application of clustering to National Park User Survey information has occurred (see Honours Project by L. Lee, Department of Recreation, University of Waterloo, 1975). This analysis did result in some important findings for planning. It showed, for example, that only about 5 percent of the visitors to a particular park participated in three or more interpretive activities. These visitors came primarily from the people who stayed two, three or more nights in the park. But, little more was found out about these visitors for a very important reason. The cluster analysis study, because of how little could be said about visitors, showed that many of the questions asked in the study had little value in understanding the visitor to the park. In contrast to what was asked, such important questions as questions about visits to the townsites, within Banff or Jasper, and motivational questions about the why and wherefor of a park visit were not asked.

Further comment on TN 32 might be appropriate if it were not for the fact that TN 13 (which appears in Chapter 9) presents some comments on the importance of clustering in making projections of future recreation behaviour that elaborate on the points made in TN 32.

Regarding equity considerations and other applications of cluster analysis raised in the article, it is fair to say that the more detailed reference could be made to TN 10 results. Nevertheless, in such a review it is probably sufficient to suggest that some article in the CORD Study should have made more of the fact that a very high percentage of Canadians do not participate in more than a few of the more than 18 outdoor activities receiving consistent consideration in CORD Study National Surveys. The justification for not pursuing the policy implications of the "equity of participation" findings is the problem of whose policy to consider. It seems to the reviewer that descriptive findings of practical interest could have been presented without getting too involved in policy matters.

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CHAPTER VII

SURVEY METHODS - ANALYSIS METHODOLOGY

INTRODUCTION

All the articles included in this chapter arose because of the need to pursue certain issues. The nature of these needs is most easily seen in the context of a number of comments about why different papers were prepared. For example, very brief comment gives the reader the necessary background about the preparation of the first three Notes in this chapter. TN 15 was prepared because a number of CORD Study documents found it difficult to understand what analysis methodology described in TN 12 really accomplished. By using an example in which the meaning of effects could be more easily analyzed, it was felt that many readers would see the results in such a way that they could relate them to the socio-ecomomic effects referred to in TN 12. It was quite by accident that data on distance from the Continental Divide and elevation were studied in relation to the depth of snowfall. The data were provided to the CORD Study researchers at Parks Canada by Thorsell Banff, a researcher whose studies of wilderness use are well-known and who is now (1976) employed in Alberta.

One might have thought that comparing the CORD Study National Survey results with other data which are available on people's participation in the same activities would be an obvious step in any research where there is a concern with reliability and validity. This is what prompted making the comparison presented in TN 24. In fact, making this comparison is one of the factors that motivated the inclusion of questions about different types of hunting and fishing in the 1972 CORD Study of people's participation in outdoor recreation activities (see the CORD Study Data Documentation Volume).

TN 38 was prepared when it was necessary to produce rather quickly figures on the value of park experiences. As those familiar with the procedure used by Knetsch and Cheung in preparing their estimates for TN 31 realize, it is not a trivial matter to compute a demand function for the use of a given park. When there is the possibility of obtaining demand functions for hundreds of parks with different characteristics, one is prompted to look for a methodology that has a relatively sound theoretical basis and still can be quite simply applied. The fact that developing such a methodology pays other dividends in terms of showing researchers the problem in estimating the time bias is simply one of those fortunate coincidences that characterize much of the progress that has been made in research.

TN 21 has an interesting history. The first design work

on CORD Study surveys of park use was the work done for a 1968 pilot survey. As indicated in the Data Documentation Volume, when plans actually went ahead for major park users surveys in Canada in 1969 and 1970, this pilot survey was scrapped in favour of using an entrance survey methodology proposed by Chubb and Crapo. The design work for the 1969 survey actually had much to recommend it, given what was not known about park use (volume of park use on different days, etc.). However, the way the days on which to survey were defined and the sampling rates, recording procedures for keeping track of forms handed out, etc., were specified did not lead to good results. Large volumes of information were lost, surveyors did not adhere to schedules, there were no records of hours of the day during which questionnaires were handed out, etc.

However, the experience did prompt the statistician who was responsible for the earlier design to come up with a much more sophisticated system in 1971. This was no longer for the CORD Study but for a National Park User Survey. The Survey was intended to meet the objectives of Parks Canada. Users of the data collected were to be able to make seasonal use estimates and to give profiles of entry over different types of days. In developing the design, there was also the practical concern of seeing that the survey staff stayed as busy as possible so that accuracy was maximized. The 1971 Design evolved in 1972 and 1973 so that in TN 21 it is possible to report on a survey system that is improved but recognized to be still far from optimal. In the paper one only sees the pinnacle of development in 1973 and not the agonizing effort that preceeded it. The reader should be careful to recognize that the problems that can be seen at the 1973 stage do not reflect initial poor work but rather the cumulative improvement that can take place as experience is gained.

TN 8 is much more important in the history of the way the Canadian Outdoor Recreation Demand Study evolved than the results indicate. Thinking of the issues which prompted the development of the note resulted in conceptual clarification both about model development and problems of data collection. Explicitly confronting the issue of how to use information about the occupancy of campsites on different days during a season (given the nature of the use pattern involved) reinforces one's concern with the difference between week-end use and week-day use. It also stresses the fact that there are not only week-end and week-day users of parks but any number of kinds of users to whom different models (different reactions to distance, different park attractiveness, etc.) must apply. So this note should be read in the context just described. However, it should also be noted that the analysis procedure described has been used to extract information about an expected use pattern for a park from limited survey information and this use pattern has been applied to make week end, week day-use estimates for planners. Incidentally, Scottish researchers Dufield and Archer have recognized the merits of carrying

out a similar procedure in studying tourism in Scotland.

In Chapter VI, reference was made to Romsa's et al. methodological work on deriving recreation activity packages using CORD Study National Survey data. Another methodology has also been used to analyze these data: this is a methodology proposed by Burton for deriving clusters of activities. Thus, it is possible to present in one paper the consequence of carrying out an analysis to define clusters of activities and to define activity packages. Such results are presented because early in the CORD Study it was deemed extremely important to deviate from an activity by activity analysis perspective and examine people's behaviour in terms of the broad range of activities in which any one individual may participate. Romsa was engaged by Parks Canada on contract to carry out a cluster analysis in such a way as to group people on the basis of the activities in which they participate. This was at the same time that Gillespie was a student of Burton. Gillespie took advantage of the availability of the 1969 CORD Study Participation in Outdoor Activities data to prepare a thesis in which he showed the results of applying the factor analysis approach of Burton to derive clusters of activities.

It was only in 1975 that the decision was made to produce a paper that included the results of both analyses. This was done so that the analyses could be seen together and thus could be used (1) in getting a better view of the issues raised in TN 32 and 37 and (2) so that the results could be used by managers and researchers to get a perspective on what types of people the Canadian population encompasses in terms of their participation and outdoor activities.

TN 19 arose in a very interesting way. Knetsch, after being closely involved with the CORD Study for many years (1966 - 1972), accepted an appointment in Malasyia. However, while there he continued to work on CORD Study data because of his interest in the study. He was concerned, for one thing, because in developing destination models it was very often the case that the models did not appear to be as good as they should be. At the same time the CORD Study research group with Parks Canada was investigating this same problem. So when a paper by Knetsch arrived in Ottawa, the question that Parks Canada researchers raised was not whether the method that Knetsch proposed for weighting observation in carrying out a regression was valid, but whether his weights were the best weights to use. In trying to answer the question it was found that a set of weights, which are appropriate in a large number of circumstances, could be derived theoretically. This was the beginning of TN 19 in its present form. However, as work on it continued it became clear that the theoretical results opened up the possibility of making a test as to the actual acceptability of a given model. From this sequence of events, TN 19 arose.

In 1973, while Knetsch and Parks Canada researchers were working on one version of TN 19, Goodchild was engaged on contract by Parks Canada to do work testing models to see

if they were structurally sound and gave accurate descriptions of origin destination flows. The research on using weighted regression was already far enough developed that Goodchild made use of the material and was able to comment on using a simulation approach and various weighted and unweighted regression procedures to test the goodness of models. He was able to comment on how a comparison between simulated results and real data indicated whether a model was valid or not. Ultimately, TN 35 came to be (in many respects) similar to TN 19 which it was originally to complement. Nevertheless, TN 35 makes unique contributions by presenting results of structural error on estimating model parameters accurately, and by illustrating a number of matters in relation to accuracy achieved, using weighted or unweighted regression, with or without non-linear estimation methods. Goodchild's TN 35 is complementary to, not redundant with, TN 19.

Some of the issues discussed in Goodchild's TN 36 have been recognized for some time as people such as Cicchetti, Ferard and Davidson worked on origin models (see TN 34). But concerns discussed have not been brought together. It was the recognition of this fact that prompted Parks Canada to have work done on the value R^2 should be expected to have when the the kind of models used in TN 12 (also TN 6, 20 and 29) are developed.

The final note in this chapter (TN 42) was prepared because many systems for handling geographic information are being used (perhaps misused is a better word) by recreation researchers. Little information is available that allows the practitioner to know what such systems are capable of doing. A simple overview of the issues involved in processing simple geographic information has not been available. The paper presented, meets some of these needs by presenting general concerns and specifics about a system that was developed using a knowledge of problems that were relevant to CORD Study and other recreation researchers.

DEPTH OF SNOWFALL AND ITS RELATION TO DISTANCE FROM THE CONTINENTAL DIVIDE AND ELEVATION ABOVE SEA LEVEL

H.K. Cheung and J. Beaman

ABSTRACT

The objective of this paper is to present the results of determining the parameters of an equation to be used to predict snowfall in terms of the two variables, elevation and distance from the continental divide.

The note is not provided as seminal or definitive research. (It is often difficult to obtain simple examples of the application of a technique that can be used in a wide class of situations.) It does offer a simple and easily understood application of the analysis of variance to a practical problem.

OBJECTIVE

This paper presents the results of determining the parameters of an equation to be used to predict snowfall in terms of the two variables, elevation and distance from the continental divide. It will prove useful to the reader who is not familiar with the analysis of variance by providing a simple example that will enable him to give a firm, intuitive grasp of the kind of analysis that can be carried out when some variables are nominal independent (for example, occupation and marital status).

APPROACH TO ANALYSIS

The data given in Table 1 were available for analysis. These data provide information that may suggest a distance or elevation relation of some significance in searching for potential ski areas on the basis of available information on elevation and location of the divide. Elevation and distance from the divide could also be treated as continuous (interval) variables.

There was no reason to expect a linear relationship (or any particular relationship, for that matter) between the variables considered. Given the limited data available, it was decided to use an analysis of variance model (see Reference 50) to describe the effects that are described later. Use of an analysis of variance model requires that

TABLE 1

SNOWFALL DATA FOR THE CANADIAN ROCKIES
(IN THE AREAS INDICATED)

Snow Station	Elevation (feet)	West Distance from Divide (mi.)	Average Annual Snowfall (19 yr ave.)
01 Canmore	4350	24	62
02 Kanaskia Cabin	5500	8	134
03 Kananaskis Lookout	6800	10	151
04 Pocatterra Creek	6720	12	123
05 Highwood Pass	7250	6	173
06 Mud Lake	6220	8	180
07 Evans-Th. Creek	4950	20	103
08 Whiteman Pass	5600	12	85
09 Elbow Lake	7150	12	175
10 Exshaw	4200	21	76
11 Kanaskis Station	4560		102
12 Anthracite	4550	20	64
13 Banff Town	4582	17	79
14 L. Louise*	5032	5	193
15 Sunshine (3 yr. av.)	7200	0	308
16 Norquay (3 yr. av.)	6120	17	100

* Note discrepancy in Plan for snowfall at Louise.

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data be grouped to give categories but, because data was limited, this grouping was not expected to cause a great loss of information. It also made it possible to avoid the assumption that snowfall was a function of distance from the divide and elevation of the form:

Snowfall = U + C(1) (elevation) + C(2) (distance from divide)

WHERE C1 and C2 are constants.

The categories used in grouping data were selected to correspond with "natural" groupings in the data and so that the parameters to be estimated (could) be estimated. The design matrix was of full rank and did not involve too much multicollinearity between components being considered. The categories used are given in Table 2.

TABLE 2

CATEGORIES USED IN THE ANALYSIS OF VARIANCE

ELEVATION CATEGORIES		DIVIDE DISTANCE CATEGORIES	
Category	Elevation in feet above sea level	Category	Distance from divide in miles
1	Up to 4999	1	0 - 6
2	5000 - 5999	2	7 - 12
3	6000 - 6499	3	13 - 19
4	6500+	4	20+

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The model for which estimation was carried out can be interpreted as follows:

Total snowfall for an elevation in Category X
and the distance from the divide in Category Y

=

General snowfall

+

Elevation effect for elevation Category X

+

Distance from the divide effect
for distance Category Y.

RESULTS OF ESTIMATION

Many ways exist to estimate the "effects" that the equation above indicates must be estimated. They are outside the scope of this paper. (For two methods, see Reference 00; for discussion of methods using standard regression programs, the dummy variables method, see Reference 00.) When analysis of variance of snowfall data was carried out, a fairly good explanation was achieved. A usual criterion for goodness of explanation is the ratio R^2 which is the explained sum of squares to the total sum of squares. An R^2 of .79 was achieved. Estimated values of coefficients for which results were obtained are given in Table 3. To show

how well the predictions correspond with observations, Table 4 presents both observed and predicted results.

TABLE 3

ESTIMATED PARAMETER VALUES

General Snowfall Level = 130.95 inches

ELEVATION EFFECTS

Category	Categories meaning (Elevation in feet)	Effect
1	Up to 4999	9.33
2	5000-5999	-41.63
3	6000-6499	30.33
4	6500+	.97

DISTANCE EFFECTS

	(Miles from divide)	
1	0 - 6	106.61
2	7 - 12	18.72
3	13 - 19	-61.28
4	20 +	-64.03

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Table 4 actually has several functions. By looking at it, one can see the effects that were added together to get a given observation. Given a hypothetical situation of the snowfall at 7,500 feet at 32 miles from the divide, the estimate of snowfall is obtained just as it is in Table 4 for a known site. Also, from the estimated parameter values in Table 3 it is seen that the combination of 6000-6499 feet of elevation and 0-6 miles of distance from the divide will have the largest positive effect on snowfall. Whether this is reasonable requires a thorough knowledge of the geography of the study area.

Snowfall = general snowfall + (6,5000 + ft elevation effect)
+ (20+ miles distance effect)

There is the possibility that the residuals shown in Table 4 show some kind of systematic error. There could be a distance-elevation interaction meaning that combinations of

distance from the divide and elevation may be conducive to high or low snowfall in a way that is not expressed by simply adding an elevation effect and a distance effect. Patterns such as these do not seem apparent in the data.

It is also possible that large differences between observations and predictions that are seen in Table 4 may be related to a third variable, which was not considered in this analysis. Obvious variables to consider are orientation and steepness of the slope on which the measurement was taken. Or the residuals may indicate something about the nature of the divide near the area being considered. Large negative values of residuals may indicate one kind of divide terrain while positive residuals may indicate quite different geographic characteristic of the nearby divide. Such factors are likely to be picked out by somebody with a "feel" for the areas but which are almost never detected in a purely ad hoc statistical approach to a problem.

TABLE 4

OBSERVED AND PREDICTED VALUES
FOR THE OBSERVATION UNITS

Unit	Obs. Snow fall	Predicted Snowfall (inches)	Residual	Elev. Variable Value	Dist. Variable Value
01	62	76 = 131 + 9 - 64 = 76	- 14	1	4
02	134	108 = 131 - 42 + 19 = 108	26	2	2
03	151	151 = 131 + 1 + 19 = 151	0	4	2
04	123	151 = 131 + 1 + 19 = 151	- 28	4	2
05	173	239 = 131 + 1 +107 = 239	- 66	4	1
06	180	180 = 131 + 30 + 19 = 180	0	3	2
07	130	76 = 131 + 90 - 64 = 76	27	1	4
08	85	180 = 131 - 42 + 19 = 108	- 23	2	2
09	175	151 = 131 + 1 + 19 = 151	24	4	2
10	76	76 = 131 + 9 - 64 = 76	0	1	4
11	64	76 = 131 + 9 - 64 = 76	- 12	1	4
12	79	79 = 131 + 9 - 61 = 79	0	1	3
13	193	193 = 131 - 42 +106 = 195	- 2	2	1
14	308	238 = 131 + 1 +106 = 238	70	4	1
15	100	100 = 131 + 30 - 61 = 100	0	3	3

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DISCUSSION OF THE RESULTS

When examining Table 4 one sees that the range of residuals varies from -66 to 70 with an average error of 14.2 percent. It is interesting to note that among the residuals, the two largest (-66 and 70) are associated with observation units that are at short distances from the divide and have high elevations. Reasons for this large discrepancy are not immediately apparent from the data. Some variables that are of importance in explaining snowfall (and that were excluded from the analysis) may account for these large residuals. Nevertheless, this model as it is may yield poor prediction of snowfall for an observation unit at a high elevation that is also at a short distance from the divide. On the other hand, it seems clear that it may give relatively good predictions for those observation units for which other combinations of elevation and distance from the divide exist.

The use of average annual snowfall as the dependent variable may present some problems, since large extreme values of snowfall were observed. Since the mean snowfall is affected appreciably by large extreme values, the median might have been a better dependent variable that could be used in the analysis is the annual (or even monthly) snowfall for each observation unit. The use of time series data offers the advantage that the situations being modelled are more truly reflected in that variations that occur over time are open to explanation. On the other hand, the use of time series data requires the specification of variables and related parameters to be used to account for over time (annual) variations in snowfall. In a model developed for time series data it might occur that a multiplier to correct for level of snowfall could be applied so that:

Observation for year t = (level multiplier for year t) *
(general mean + elevation effect + distance effect).

When analysis is carried out on more data, it will be possible to correct for different variances on observations and intercorrelations between observations. The present analysis simply ignores the fact that observations at different stations are almost certainly correlated. Also it is reasonable to think that there will be more variation (absolute) in amount of snow in high snowfall areas than in low snowfall areas. Though the lack of knowledge about these factors does not cause a bias in the results presented, it lowers the efficiency of the estimates, meaning that better predictions could be made.

It may have occurred to some readers that the parameter values in Table 3 are difficult to accept in a practical sense. For instance, the difference between elevations 5999 feet and 6000 feet is only one foot and yet the difference in the effect of snowfall is almost 72 inches. The difficulty clearly is one of interpretation. The reader is reminded that the explanatory variables used are not

continuous but are categorical or classificatory. As such, the parameters presented must be interpreded accordingly: the difference in effect on snowfall between elevation category 2 and category 3 is almost 72 inches. One could associate parameter values with a category mean and then draw a curve through the parameter values. The "appropriate" parameter for an elevation could be read from the curve and this estimate would not suffer from the problem just noted.

CONCLUSION

The model derived suggests a reasonable means of predicting snowfall for a weather station in terms of its elevation measured in feet and its distance from the divide measured in miles. There is no assumption that depth of snowfall varies largely with the two variables considered; and the results suggest that it does not. It is only assumed that the effects on snowfall due to the explanatory variables can be separated so that the overall effect is the sum of the individual effects. Interaction between the explanatory variables used was not hypothesized, since such a relationship was not apparent from the data provided. Exclusion of explanatory variables that are significant in predicting snowfall (such as the nature of the terrain) may have caused the two large residuals mentioned before. Of course, the adequacy of the model to predict can only be determined after it has been applied to additional sets of data.

THE COMPARABILITY OF NATIONAL SURVEY DATA ON PARTICIPATION IN HUNTING AND FISHING WITH OTHER DATA ON THE SAME OUTDOOR RECREATION ACTIVITIES

S. Rousseau

ABSTRACT

Research scientists can have little faith in results obtained and conclusions drawn from a study if the reliability and validity of the data are not known or cannot be established.

This paper takes a step toward measuring the reliability and validity of data from certain national surveys on participation of Canadians in outdoor recreation activities. The procedure followed is to (1) test reliability by determining if the measurements are consistent, and (2) test validity by comparing the results of national surveys with the findings of independent studies.

In the comparisons reviewed, a variation of 10 percent between the data of the national surveys and that of the control sources is sometimes used as the critical threshold value. When the data permit, significance tests are applied to discover if the differences noticed between percentages of the national surveys and the percentages of the "control" sources were chance differences due to sampling or not.

In the first part of the paper, the statistical data used are presented and some explanations about the national surveys are given. The significance tests used are explained in a second part. Data on hunting and fishing are compared in the two remaining sections.

OBJECTIVE

Criticism concerning the reliability and validity of data have been raised about some national surveys on participation of Canadians in outdoor recreation activities because no reliability and validity analyses had been presented. The objective of this paper is to take a step towards measuring the reliability and validity of some CORD Study National Survey results.

INTRODUCTION

Concern for reliability comes from the necessity for dependability in measurement and, in its simplest form, refers to the prospects for obtaining consistent and similar measurements when a data collection procedure is replicated. Kerlinger (see Reference 36) approaches the concept of reliability with three questions.

1. If we measure the same set of objects again and again with the same or comparable measuring instrument, will we get the same or similar results?
2. Are the measures obtained from a measuring instrument the "true" measures of the property measured?
3. How much error of measurement is there in a measuring instrument?

In a similar vein Kendall and Buckland (see Reference 35) propose a functional definition of reliability which takes into consideration the concepts of stability and random error. Reliability is conceived as "that part which is due to permanent systematic effects, and therefore persists from sample to sample, as distinct from error-effects which vary from one sample to another."

The merits of having reliability figures as a measure of accuracy are obvious. However even if the statistical results are proven to be accurate, statistically stable and precise, this alone cannot convince the reader that the results obtained are valid. Reliability does not take into consideration the congruence of the object measured with that of the measuring instrument. In practical terms, techniques for assessing reliability determine the statistical accuracy and reproducable precision of the measuring instruments but neglect to show whether or not the measuring instruments truly measure what was intended to be measured in the first place. It is therefore quite possible to have reliable statistical results that are not accurate in the sense of being valid.

Kendall and Buckland (Reference 35, p. 309) propose a definition of validity which takes into consideration the representativity of a sample and is otherwise known as content validation by Kerlinger (see Reference 35). Validation is "a procedure which provides, by reference to independent sources, evidence that an inquiry is free from bias or otherwise conforms to its declared purpose. In statistics it is usually applied to a sample investigation with the object of showing that the sample is reasonably representative of the population..." In this context a good test for validity is to compare survey results with the finding of independent non-survey studies. If the results are similar, one can assume that the survey is probably valid.

The procedure that is followed in this paper is (a) to

test the reliability of the national surveys by determining if the measurements are consistent from survey to survey, and (b) to test the validity of the national surveys by comparing their results with the findings of independent studies.

Although it is not particularly desirable, in the comparisons presented in this paper a variation of 10 percent between the data of the national surveys and that of the control sources is sometimes used as the critical threshold value for questioning the reliability and the validity of the results of the national surveys. However, when data permit, significance tests are applied to discover if the differences noticed between percentages of the national surveys and the percentages of the "control" sources were chance differences due to sampling or not.

THE STATISTICAL DATA COMPARED

The CORD Study National Survey results to be tested for reliability and validity are described and data documentation provided elsewhere (Volume III). Briefly, in these surveys, questions were asked to determine the participation and frequency of participation of respondents in outdoor recreation activities. In 1967, 22 activities were covered; in 1969, 26 activities were covered and in 1972, there were 28 activities. (For more detail see TN 22.) Participation in hunting was obtained in 1967, 1969 and 1972; however information on specific types of hunting (small game, large game, waterfowl) was obtained only in the 1972 survey. Information on fishing was obtained in 1967 and 1972 while participation in specific types of fishing (salt water, fresh water) was procured only in 1972.

The other data sources used for the comparisons in this research paper are shown in Table 1. The National Survey results (Sources 1-4) are compared with statistical data from other sources (5-10) described in the Appendix. The variations in the methods of data collection, years of data collection and age groups for which the data were collected are noted in describing the respective studies.

COMPARISON OF HUNTING DATA

The 1967, 1969 and 1972 SM surveys may be compared to provide some check on survey reliability. From Table 2, it can be seen that as far as hunting in general is concerned, the percentage of Canadians who hunted was fairly constant from 1967 to 1972. The maximum variation is 3%, i.e. when 1967 and 1972 percentages are compared. This difference is small enough that it probably reflects trends over time so that the data on hunting seem reliabe even if the 3% maximum difference is highly significant ($\alpha > .002$). When the data from the three national surveys are compared on a regional basis (see Table 2), the maximum differences between two

TABLE 1

DATA SOURCES AND THEIR CHARACTERISTICS

Sources	Type of Data
1) 1967 CORD Study National Participation Survey	National Survey by Personal interviews
2) 1969 CORD Study National Participation Survey	National Survey by Personal interviews
3) 1972 CORD Study National Participation Survey	National Survey by Personal interviews
4) D.A. Benson, "Fishing and Hunting in Canada 1961: A report on an Economic Survey."	Labour Force Survey Sample of 30,000
5) "Statistics on Sales of Sport Fishing Licences in Canada 1966-1971".	Figures on licence sales and fees on the basis of information provided by the agency responsible in each jurisdiction.
6) "Report on Sales of the Canada Migratory Game Bird Hunting Permit, Migratory Game Bird Harvest and Hunter Activity, 1971".	Canadian migratory game bird hunting permits sold post offices across Canada and a Harvest Survey.
7) "Travel, Tourism and Outdoor Recreation: A Statistical Digest 1972"	Information drawn from variety of sources.
8) P.G. Whiting, "A Comparison of Two Estimates of Angler Numbers in Canada."	Compares 1972 National Survey data on Fishing, Recreation Fisheries Branch estimates of angler numbers in Canada and U.S.A. 1970 Survey of Hunters and Fishermen data.
9) "National Survey of Fishing and Hunting 1970".	8,700 sportsmen were interviewed, age 12 years and older who participated on any of three different days or more, or spent $7.50 or more to go fishing or hunting during 1970.

TABLE 1 (contd.)

Sources	Year of Data	Age Groups to
1)	Fall of 1967	18+
2)	Fall of 1969	18+
3)	Fall of 1972	10 and 18+
4)	February 1962	14+
5)	April 1 to the next March 31 for 66, 67, 68, 69,70,71 and	16+ to 19+ depending on agencies licencing practices.
6)	Sales of permits from August 1971 through January 1972. 10,603 useable mailed question-aires for Harvest Survey.	Unspecified
7)	Between 1965 and 1971	Unspecified
8)	1967, 1970, 1972 figures are compared.	10+, 12+, 16+ and 18+
9)	1970	12+

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surveys are all still less than 10%. Only two differences (out of 8) are significant (Canada: $\alpha > .002$; Ontario: $\alpha > .001$ differences have the low probability of occurring as shown).

A comparison of the 1961 Canadian Wildlife Survey and the 1972 national survey results presents major problems from the point of view of evaluation of what differences mean. The results shown in Table 3 may reflect an increase in participation in hunting in Canada between 1961 and 1972. It will also be noticed that the age groups of the two surveys compared do not coincide exactly. However all the increases are less than 10% and so the 1972 national survey results seem plausible even if three differences out of four which were tested are highly significant ($\alpha < .001$). Considering that the wild life survey was a "focused survey" with much "tighter" sampling controls carried out and with many basic differences from the 1972 national survey, it is encouraging to see that differences are as small as they were found to be.

Comparison of 1970-71 Hunting Licences Sales Data and the 1972 National Survey data, Canada and Provinces, potentially allows the testing of survey validity. Thus it is fortunate that the two types of data on hunting in general (Table 4), the 1972 National Survey and the 1970-71 Hunting Licences Sales yield similar results except for three Western Provinces. In the western provinces there could be problems such as (1) unreliability of the national survey sample as far as provinces are concerned; (2) special circumstances surrounding licence regulations; or (3) the failure of many people to actually hunt after purchasing hunting licences. Actually 5 out of 8 differences tested are significant, reflecting some basic discrepancy between the two data sources.

The same similarity between 1972 National Survey results and Licence data is seen in Tables 5-7. Yet here again similarity is associated with statistically significant differences. In Table 5 are shown the differences of percentages of participants in Small Game Hunting. It will be noticed that all differences are less than 10% and still three of these differences out of 8 are highly significant. In Table 6, on Large Game Hunting, only one difference is greater than 10% but 4 differences out of 8 are significant. In Table 7, we notice that as far as Waterfowl Hunting is concerned the 1972 National Survey results are not very different from Permit Sales estimates. None of the differences are close to 10%; however 3 differences are statistically significant.

Comparison of U.S.A. 1970 National Survey data on Hunting and 1972 National Survey is of some value. Canadian and U.S. statistics are often quite similar. As can be seen from Table 8, there is similarity as far as percentage of hunters are concerned, even when the sexes are considered separately; all differences are much lower than 5% which is indeed surprising. Significance tests could not be applied to figures by sex, as data on the number of males and

TABLE 2

PERCENTAGE OF CANADIANS 18 YEARS AND OVER
WHO DID NOT PARITICIPATE IN HUNTING
IN 1967, 1969, AND 1972, BY REGION,
ACCORDING TO NATIONAL SURVEY DATA

	1967		1969		1972		Maximum Difference
	%	#	%	#	%	#	X
Canada	14	5986	13	2967	11	3002	3%
Atlantic Provinces	21	625	15	288	21	295	6
Quebec	11	1742	12	882	10	870	2
Ontario	12	1972	10	1003	8	1018	4
Manitoba	8	320	11	147	12	148	4
Saskatchewan	12	291	19	124	16	132	7
Alberta	14	433	14	217	8	251	6
British Columbia	15	603	16	306	15	288	1

	Standard Error of maximum difference $\gamma D\%$	Confidence Coefficient $Z(c) = x/\gamma D\%$	Significance Level α
Canada	1.00% (67-69)	3.00	> .002
Atlantic Provinces	3.18 (72-69)	1.89	> .05
Quebec	1.48 (69-72)	1.35	> .17
Ontario	1.23 (67-72)	3.25	> .001
Manitoba	2.85 (67-72)	1.40	> .16
Saskatchewan	3.72 (67-69)	1.88	> .06
Alberta	2.90 (69-72)	2.07	> .03
British Columbia	2.93 (69-72)	0.34	> .73

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TABLE 3

COMPARISON OF RESULTS OF 1961 CANADIAN WILDLIFE SERVICE SURVEY AND 1972 NATIONAL SURVEY OF CANADIAN HUNTERS (SIGNIFICANCE TEST)

	C.W.S. 1961 Survey Age 14+ (N=30,000) (a)	National 1972 Survey Age 15+ (N=3,255) (b)	Difference x = b−a
Hunting (all types)	6.5%	11.1%	4.6%
Small Game Hunting	3.4	8.0	4.6
Large Game Hunting	3.8	5.0	1.2
Waterfowl Hunting	2.8	3.4	0.6

	Standard Error of the Difference γD%	Confidence Coefficient Z(c) = x/γD%	Significance Level α
Hunting (all types)	.45%	10.22	< .000
Small Game Hunting	.32	14.38	< .001
Large Game Hunting	.32	3.75	< .001
Waterfowl Hunting	.32	1.88	.06

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females in the U.S. sample were not available. However, as might be suspected, superficial similarity is contrasted by statistical difference. Three out of 4 tests show that the differences are highly significant.

SYNOPSIS ON HUNTING COMPARISONS

Out of 60 comparisons on participation in hunting, only 7% (4/60) of the differences computed are greater than 10%. However 47% of the α's computed (23/49) are significant statistically. There are few large differences between national survey results and results from other sources, even though almost half of the differences are statistically different. In more detail, the national survey data on Canadian hunters are consistent for the three years: 1967, 1969, and 1972. They are not very different from the data collected in a comparable survey in 1961. The 1972 results are also quite similar to to estimates of hunters made from Licences Sales data, and that is true for all types of hunting: small game, big game, and waterfowl hunting. The percentages of Canadian hunters given by the 1972 survey are also very similar to 1970 U.S.A. data. In sum, it seems that the hunting data are resonably reliable and valid.

TABLE 4

COMPARISON OF PERCENTAGES OF CANADIAN HUNTERS (ALL TYPES) ACCORDING TO 1970 - 1971 LICENCE SALES AND 1972 NATIONAL SURVEY, CANADA AND REGIONS (SIGNIFICANCE TESTS)

	1970-71 Hunting Licences Sales, 16+* (u)%	1972 National Survey Hunters, 16+ (X)%	#	Difference X% - u%
Canada	15.8	10.8	3155	-5.0%
Atlantic Provinces	18.5	15.4	312	-3.1
Quebec	9.3	10.3	917	1.0
Ontario	11.5	9.3	1069	-2.2
Manitoba	13.6	11.1	153	-2.5
Saskatchewan	26.2	13.7	139	-12.5
Alberta	34.5	9.6	260	-24.9
British Columbia	28.8	12.8	305	-16.0

	γD%=100 (pq/n)**1/2	Confidence Coefficient (Zc=X-u%)/ γD%	Significance Level α
Canada	0.55%	-9.09	< .001
Atlantic Provinces	2.05	-1.51	> .13
Quebec	1.00	1.00	> .31
Ontario	0.89	-2.47	> .01
Manitoba	2.53	-0.99	> .32
Saskatchewan	2.92	4.28	< .001
Alberta	1.82	13.68	< .001
British Columbia	1.92	8.33	< .001

* Licence sales % were calculated from absolute number of Licence Sales given in Statistics Canada, TRAVEL, TOURISM, AND OUTDOOR RECREATION: A STATISTICAL DIGEST, 1972, CAT. 66-202, Table 8.7 p. 94. Population 16 years and over is given in 1971 Census of Canada, Statistics Canada, CAT. 92-715/716.

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TABLE 5

COMPARISON OF PERCENTAGES OF CANADIAN SMALL GAME HUNTERS ACCORDING TO 1970 -1971 LICENCE SALES AND TO 1972 NATIONAL SURVEY, CANADA AND PROVINCES (SIGNIFICANCE TEST)

	1970-71 Small Game Hunting Licences Sales, 16+* (u)%	1972 National Survey Small Game Hunters, 16+ (X)%	#	Difference X% - u%
Canada	7.1	7.7	3155	0.6%
Atlantic Provinces	7.3	12.5	312	5.2
Quebec	5.1	7.2	917	2.1
Ontario	7.1	7.4	1069	0.3
Manitoba	6.7	6.5	153	-0.2
Saskatchewan	9.9	9.4	139	-0.5
Alberta	7.8	5.8	260	-2.0
British Columbia	10.7	6.6	305	-4.1

	$\gamma D\% = 100\ (pq/n)^{**}1/2$	Confidence Coefficient (Zc = X%- u%)/$\gamma D\%$	Significance Level α
Canada	0.45%	1.33	> .18
Atlantic Provinces	1.87	2.78	> .005
Quebec	0.83	2.53	> .01
Ontario	0.78	0.38	> .70
Manitoba	2.00	-0.10	> .92
Saskatchewan	2.47	-0.20	> .84
Alberta	1.45	-1.38	> .16
British Columbia	1.41	-2.91	> .003

* See remarks below Table 4.

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TABLE 6

COMPARISON OF PERCENTAGES OF CANADIAN LARGE GAME HUNTERS ACCORDING TO 1970 - 1971 LICENCE SALES AND 1972 NATIONAL SURVEY, CANADA AND REGIONS. (SIGNIFICANCE TEST)

	1970-71 Large Game Hunting Licences Sales, 16+* (u)%	1972 National Survey Large Game Hunters, 16+ (X)%	#	Difference X% - u%
Canada	7.1	5.1	3155	-2.0%
Atlantic Provinces	10.6	9.0	312	-1.6
Quebec	3.9	4.1	917	0.2
Ontario	3.1	3.7	1069	0.6
Manitoba	6.9	6.5	153	-0.4
Saskatchewan	16.3	7.9	139	-8.4
Alberta	14.3	3.8	260	-10.5
British Columbia	18.1	8.2	305	-9.9

	D% = 100 (pq/n)**1/2	Confidence Coefficient (Zc = X%- u%)/γD%	Significance Level α
Canada	0.45%	-4.44	< .001
Atlantic Provinces	1.61	-0.99	> .32
Quebec	0.63	0.32	> .74
Ontario	0.55	1.09	> .27
Manitoba	2.00	-0.20	> .84
Saskatchewan	2.28	-3.68	< .001
Alberta	1.18	-8.90	< .001
British Columbia	1.58	-6.27	< .001

* See remarks below Table 4.

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TABLE 7

COMPARISON OF PERCENTAGES OF CANADIAN WATERFOWL HUNTERS ACCORDING TO 1970 - 1971 LICENCE SALES AND 1972 NATIONAL SURVEY, CANADA AND REGIONS (SIGNIFICANCE TEST)

	1971 Migratory Game Bird Hunting Permit Sales, 16+* (u)%	1972 National Survey Waterfowl Hunters, 16+ (X)%	#	Difference X% - u%
Canada	2.6	3.5	3155	0.9%
Atlantic Provinces	3.6	3.5	312	-0.1
Quebec	1.2	2.5	917	1.3
Ontario	2.3	3.6	1069	1.3
Manitoba	5.4	5.2	153	-0.2
Saskatchewan	6.6	7.2	139	0.6
Alberta	5.5	5.0	260	-0.5
British Columbia	2.0	2.6	305	0.6

	γD%=100 (pq/n)**1/2	Confidence Coefficient (Zc = X%-u%)/γD%	Significance Level α
Canada	.32%	2.81	.005
Atlantic Provinces	1.05	-0.10	> .92
Quebec	0.55	2.36	> .01
Ontario	0.55	2.36	> .01
Manitoba	1.79	-0.11	> .91
Saskatchewan	2.19	0.27	> .86
Alberta	1.34	-0.37	> .71
British Columbia	0.89	0.67	> .50

* Permit Sales % were calculated from absolute number of Permit Sales given in Canadian Wildlife Service, Progress Notes, No. 28, July 1972. Population 16 years and over is given in 1971 Census of Canada, Statistics Canada CAT. No. 92-715 and 92-716. These figures are given in Appendix.

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TABLE 8

PERCENTAGES OF HUNTERS IN CANADA (1972 NATIONAL SURVEY) AND IN U.S.A. (1970 NATIONAL SURVEY OF FISHING AND HUNTING) ACCORDING TO SEX (SIGNIFICANCE TEST)

	U.S.A. 1970, 12+ (N=8,700) (a)	Canada 1972, 12+ (N=3681) (b)	Difference x = b - a
HUNTING			
Total	9.2%	12.0%	2.8%
Males	18.3	21.3	3.0
Females	1.1	3.2	2.1
SMALL GAME			
Total	7.5	9.0	1.5
Males	15.0	16.2	1.2
Females	0.7	2.3	1.6
LARGE GAME			
Total	5.0	4.7	-0.3
Males	9.9	8.4	1.5
Females	0.6	1.3	0.7
WATERFOWL			
Total	1.9	3.7	1.8
Males	3.8	7.1	3.3
Females	0.1	0.4	0.3

	Standard error of the difference $\gamma D\%$	Confidence coefficient ($Zc = x/\gamma D\%$)	Significance Level α
HUNTING	.59%	4.75	< .001
SMALL GAME	.55	2.73	> .006
LARGE GAME	.45	-0.67	> .50
WATERFOWL	.32	5.63	< .001

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Regarding the 1967, 1969 and 1972 national surveys, it is unfortunate that only the 1972 survey gives data on detailed types of fishing. However, as far as fishing in general is concerned, the percentages of Canadians who fished is not very different in 1967 and 1972, as can be seen in Table 9. The variation between the results of the two surveys being 4%, it could be concluded that the data on percentages of Canadian sport fishers in general is fairly reliable even though this 4% difference is significant at a .001 level.

However, there are greater variations between the data of the 1967 and 1972 surveys, when one compares results by provinces, as seen in Table 10. Still, the national data, even when disaggregated to provincial levels, is fairly consistent. There is only one province (Manitoba) for which the percentages for the two surveys differ by more than 10%; this may be due to a change in licensing regulations or enforcement practices. However, some differences (even if not large) are significant (Canada: $\alpha < .001$; Quebec: $\alpha < .001$; Manitoba: $\alpha < .001$).

Generally the results in Table 11 indicate poor fit between 1961 Canadian Wildlife Service Survey data and 1972 National Survey data. It is not impossible that the percentage of Canadian fishers has increased from 11% in 1961 to 28% in 1972, but this explanation is not likely. It should be noticed that the differences are all highly significant ($\alpha < .001$) in Table 11. What is important is that one may reasonably hypothesize that the differences are partly due to differences in definitions of "fishing". In fact, for the 1961 C.W.S. survey, a person was considered a fisherman if one hour or more was spent sport fishing during 1961; for the 1972 national survey a respondent was considered as having fished in 1972 if he said that he had fished at least once in the past year. The 1961 C.W.S. survey definition of fisherman seems much more restrictive than the national survey definition. There is good reason to believe that wives who accompanied husbands on fishing trips would often say to national survey interviewers that they fished (they had been fishing) in the past year. Regardless, one or the other (or both surveys) are not valid in all likelihood.

Comparison of 1970-71 Estimate of Anglers from Sport Fishing Licences in Canada and of percentage of fishers according to 1972 National Surveys results in the figures given in Table 12. Then it can be seen that the two estimates of the numbers of Canadian fishermen differ considerably, not only when provinces are considered but even when Canada as a whole is considered. The 1970-71 estimates of anglers from licences sales are much closer to the 1961 C.W.S. survey figures (see Table 11) than to the 1972 national survey percentages.

It is highly tempting to conclude from the Table 12 comparisons that the figures confirm the hypothesis that the

number of people fishing is much greater, probably twice as great as the number of Canadians who purchase fishing licences. (Purchasing licences should not be taken literally because "licence purchases" for Ontario are estimates after 1970 since no fishing licence is required by residents.)

Of course another and better explanation for the large variation is that the differing definitions of fishermen in the two surveys mean the survey results should not agree!

As with hunting, comparison of US 1970 National Survey Data on Fishing and 1972 National Survey data is of some relevance in evaluating Canadian surveys. As can be seen from Table 13, for salt water fishing, Canadian and American percentages are almost identical for both sexes. But when fishing in general and freshwater fishing in particular are considered, the Canadian percentages are much higher than the American percentages. It may be tempting to conclude that, in fact, the percentages of Canadians who fish, particularly in freshwater, are greater than the percentages of Americans; but these facts may well indicate nothing more than the differences in the questions asked.

SYNOPSIS OF FISHING COMPARISONS

Most comparisons that were presented in this section leave the reader with the impression that the national surveys overestimate the percentage of Canadians who go fishing. The 1972 survey gives a percentage of Canadian fishers about three times greater than the percentages given by a similar survey conducted in 1961 by the Canadian Wildlife Service. The 1972 percentages of Canadians who fish are about twice as high as percentages given by a 1970-71 estimate of Anglers from Licences Sales. The 1972 percentages of Canadian fishers are much higher than 1970 American figures. This may be explained by speculative causes such as (1) participation in fishing has greatly increased in the last ten years, (2) people who go fishing without a licence are as numerous as those who get a licence and that in fact (3) freshwater fishing is more popular in Canada than in the U.S.A. However since the results of the 1967 and 1972 surveys are very similar, it appears that the "overestimate" is obtained consistently by national surveys. So it can be concluded that the survey results on fishing by Canadians are reliable (consistent), but their validity should be questioned.

TABLE 9

PERCENTAGE OF CANADIANS 18 YEARS AND OVER
WHO DID PARTICIPATE IN FISHING
IN 1967, 1969, 1972
ACCORDING TO CORD NATIONAL SURVEYS

	Fishing	Salt-Water Fishing	Fresh-Water Fishing
1967 (N=5986)	27%	-	-
1969 (N=2967)	-	-	-
1972 (N=3002)	31%	6%	29%
Maximum Difference (x)	4%		
Standard Error of the Maximum Difference ($\gamma D\%$)	1.0%		
Confidence Coefficient ($Zc=x/\gamma D\%$)	4.00		
Level of Significance	< .001		

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TABLE 10

PERCENTAGE OF CANADIANS 18 YEARS AND OVER
WHO DID PARTICIPATE IN FISHING
IN 1967 AND 1972
BY REGION (ACCORDING TO NATIONAL SURVEYS DATA)

	1967		1972		Difference
	%	#	%	#	x
Canada	27	5986	31	3002	4%
Atlantic Provinces	33	625	31	295	2
Quebec	21	1742	29	870	8
Ontario	29	1972	30	1018	1
Manitoba	17	320	38	148	21
Saskatchewan	26	291	31	132	5
Alberta	24	433	29	251	5
British Columbia	31	603	39	288	2

	Standard error of Difference $\gamma D\%$	Confidence coefficient $Zc = x/\gamma D\%$	Significance Level α
Canada	1.0%	4.00	< .001
Atlantic Provinces	3.30	0.61	> .54
Quebec	1.76	4.55	< .001
Cntario	1.76	0.57	> .57
Manitoba	4.24	4.95	< .001
Saskatchewan	4.71	1.06	> .29
Alberta	3.48	1.44	> .14
British Columbia	3.28	.61	> .54

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TABLE 11

COMPARISON OF PERCENT RESULTS
OF 1961 CANADIAN WILDLIFE SURVEY
AND 1972 NATIONAL SURVEY ON CANADIAN FISHERS

	Fishing	Fresh-Water Fishing	Salt-Water Fishing
C.W.S 1961 Survey Age 14+ (N=30,000) (a)	10.8 %	10.4%	1.2
National 1972 Survey Age 15+ (N=3255) (b)	28.3%	27.1%	5.2%
Difference $x=b-a$	17.5%	16.7%	4.0%
Standard Error of Difference $\gamma D\%$	.63%	.63%	.32%
Confidence Coefficient $Zc=x/\gamma D\%$	27.78%	26.51%	12.50%
Significance Level α	$<$ .001	$<$ .001	$<$ .001

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TABLE 12

COMPARISON OF PERCENTAGES OF CANADIAN FISHERS (ALL TYPES) ACCORDING TO 1970 - 1971 ESTIMATE OF ANGLERS FROM SPORT FISHING LICENCES AND 1972 NATIONAL SURVEY, CANADA AND REGIONS

	1970-71 Estimate of Anglers from Licences Sales, 16+* (u)%	1972 National Survey Fishers, 16+ (X)%	#	Difference X% - u%
Canada	14.2	27.5	3155	13.3%
Atlantic Provinces	17.1	25.0	312	7.9
Quebec	13.2	25.6	917	12.4
Ontario	13.0	29.1	1069	16.1
Manitoba	13.8	30.7	153	16.9
Saskatchewan	17.3	25.9	139	8.6
Alberta	12.1	24.6	260	12.5
British Columbia	14.7	32.5	305	17.8

	γ g D%=100 (pq/n)**1/2	Zc = (X - u%)/γD%	Significance Level α
Canada	0.78%	17.05	< .001
Atlantic Provinces	2.45	3.22	< .001
Quebec	1.45	8.55	< .001
Ontario	1.38	11.67	< .001
Manitoba	3.73	4.53	< .001
Saskatchewan	3.72	2.31	> .02
Alberta	2.67	4.68	< .001
British Columbia	2.68	6.64	< .001

* Licence sales % were calculated from absolute number of Licence Sales given Statistics Canada on Sales of Sport Fishing Licences in Canada 1966 - 1971, Environment Canada, September, 1973. Population 16 and over is given in 1971 Census of Canada, Statistics Canada, CA(No. 92-716. These figures are given in Appendix.

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TABLE 13

PERCENTAGES OF FISHERS IN CANADA (1972 NATIONAL SURVEY) AND IN U.S.A. (1970 NATIONAL SURVEY OF FISHING AND HUNTING) ACCORDING TO SEX

	U.S.A. 1970 Age 14+ (N 8700) (a)	Canada 1972 Age 12+ (N 3681) (b)	Difference b-a
FISHING			
Total	21.4%	31.5%	10.1%
Males	32.7	44.5	11.8
Females	11.1	19.4	8.3
SALT-WATER FISHING			
Total	6.1	5.5	-0.6
Males	9.9	8.4	-1.5
Females	2.6	2.7	0.1
FRESH-WATER FISHING			
Total	18.9	30.3	11.4
Males	29.1	42.8	13.7
Females	9.7	18.6	8.9

	Std Error of difference $\gamma D\%$	Confidence Coefficient $Zc=x/\gamma D\%$	Significance Level α
FISHING	.84%	12.02	$<$ .001
SALT-WATER FISHING	.45%	1.33	$>$ .18
FRESH-WATER FISHING	.84%	13.57	$<$ .001

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GENERAL CONCLUSION

The national surveys data seem quite reliable, i.e. consistent from one survey to another when hunting and fishing data are compared. However, the hunting data seem more valid than the fishing data when compared to other data sources. As far as hunting data are concerned, only 7% (4/60) of the comparisons show differences greater than 10%; for fishing data, 45% (13/29) of the comparisons show differences greater than 10%. While 47% (23/49) of the significance levels are less than .05 for hunting, in the case of fishing it is 74% (17/23) of the significance levels that are less than .05; i.e. 74% of the differences noticed from the comparison of fishing data are highly significant. While the hunting data seem reliable and valid, the fishing data raise many questions which the data limitations do not permit one to answer.

TABLE 15

ABSOLUTE NUMBERS FROM WHICH PERCENTAGES OF HUNTERS WERE ESTIMATED FROM LICENCES SALES

Regions	1971 Population Age 16+*	Hunting Licences Sales 1970-71**
Canada	14,742,225	2,322,800
Atlantic Region	1,336,335	247,700
Quebec	4,112,625	382,800
Ontario	5,344,935	617,000
Manitoba	681,560	93,000
Saskatchewan	625,380	163,800
Alberta	1,078,655	372,200
British Columbia	1,531,715	440,400

Regions	Small Game Hunting Licences Sales 1970-71**	Big Game Hunting Licences Sales 1970-71**	Waterfowl Hunting Permit Sales 1971***
Canada	1,044,300	1,048,800	395,622
Atlantic Region	98,100	141,000	49,414
Quebec	211,700	160,300	49,001
Ontario	378,500	165,900	125,010
Manitoba	45,800	47,200	37,668
Saskatchewan	61,700	102,100	42,525
Alberta	84,100	154,500	61,007
British Columbia	163,300	277,100	30,897

* Source: 1971 Census of Canada, Statistics Canada, CAT. No. 92-715 & 92-716

** Source: Statistics Canada, Travel Tourism and Outdoor Recreation: A Statistical Digest, 1972, CAT. No. 66-202, Table 8.7, p. 94.

*** Source: Canadian Wildlife Service, Progress Notes, No. 28, July 1972.

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TABLE 16

ABSOLUTE NUMBERS FROM WHICH PERCENTAGES OF PERSONS WHO FISH WERE ESTIMATED FROM LICENCES SALES

Regions	Estimated Anglers Age 16+ 1970-71 (Resident)
Canada	2,095,000
Atlantic Provinces	228,000
Quebec	543,000
Ontario	696,000
Manitoba	94,000
Saskatchewan	108,000
Alberta	131,000
British Columbia	225,000

Source: Statistics on Sales of Sport Fishing Licences in Canada 1966-1971, Recreation Fisheries Branch Department of the Environment, Ottawa, Ontario, September 1973.

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APPENDIX

THE SIGNIFICANCE TESTS

To determine the level of significance two different approaches were used depending on whether the comparison was done between two samples or between a sample and licence sales data.

Comparison Between Two Samples

The level of significance α is given by the Normal Curve Area Table once a confidence coefficient $Zc = x/\gamma D\%$ is obtained, where x is the difference observed between two results, i.e. between the 1967 percentage of participants and the 1972 percentage of participants. Incidentally, n1 and n2 are large so one is not concerned with the Student's T distribution.

The standard error of the difference $\gamma D\%$ is obtained by the use of the following formula for proportions:

$$\gamma(D)\% = 100\ (pq((1/n1)+(1/n2)))**1/2$$

WHERE p is the total percentage of participants in the two surveys compared,

$q = 1 - p$,

$n1$ = number in first sample, and

$n2$ = number in second sample.

Comparison Between a Sample and Licence Sales Data

In this case, the significance level is also given by the Normal Curve Area Table once a confidence coefficient Z(c) has been obtained by the use of the following formula:

$$Z(c) = (X\% - u\%)/\gamma(D)\%$$

WHERE X% is the percentage of participants in the national survey.

u% is the percentage of licence holders, and

γD% is the standard error of the difference between the national survey results and the proportion of licence holders.

The standard error of the difference γD% was calculated by the use of the following formula:

$$\gamma(D)\% = 100\ (pq/n)^{**}1/2$$

WHERE p is the percentage of participants in the survey sampl

$q = 1 - p$, and

n = number in survey sample.

If the level of significance of .05 was chosen a difference was considered as significant, not due to chance, if the probability of the difference is less than .05; i.e. there are less than 5 chances in 100 that the difference is a chance difference due to sampling. For example in Table 1, the maximum difference of 3% which is noticed between the 1967 and 1972 national surveys is significant at > .002, i.e. there is little more than 2 chances in 1000 that the 3% difference noticed is due to sampling.

QUICK ESTIMATES OF PRIMARY BENEFITS

J. Beaman, L. Lehtiniemi, V.K. Smith

ABSTRACT

This paper shows that if a travel model where visitor flow equals the product of other variables and -kD(o,d) WHERE C is an "impedance of distance" constant and D(o,d) is one way travel distance from origin to destination for main-destination trips of a given purpose the, percapita consumer surplus values can be computed very easily. It is computed from the cost per 2-way mile of travel, C, and k. Percapita consumer surplus is simply C/k. Thus, quick estimates of primary benefits, consumer surplus, are obtained simply by getting the site "demand function" without going through the approach described by Knetsch, Clawson and others to get an aggregate demand function.

Some reasons for using the quick estimation approach endorsed are presented in relation to (1)theoretical justification for the travel model suggested and (2)avoiding arbitrary decisions that must be made using the usual approach to defining Clawson-Knetsch-Hotelling demand function. The matters of (1)including time-bias in the model, (2)the effect of admission fees on identifying time-bias constraints, and some other issues are pursued.

INTRODUCTION

The purpose of this paper is to derive a simple relationship between the primary benefits associated with outdoor recreation and a class of demand relationships which have been used with considerable success in origin-destination recreation studies for Canadian Outdoor Recreation Demand (CORD). This derivation is especially useful because it follows directly from the assumed per mile costs of travel (including time) and the estimated effect of these costs on visitor use of the recreation site.

In what follows, attention is focused on the demand for a single recreation site. Substitute facilities are assumed non-existent and the total level of use of the area is assumed to be less than its economic carrying capacity. (For a definition of the meaning of economic carrying capacity and its relationship to economic carrying capacity, see Reference 19.) Since the economic rationale for the travel cost model has been developed in a number of previous studies, (see Reference 53) the focus of this paper is directed to the derivation of a consumer surplus measure for

the total population of users for the recreation site of interest.

DEMAND AND CONSUMER SURPLUS

An individual demand curve is the locus of maximum prices that individual would be willing to pay for each corresponding level of consumption of the good or service involved. Given a single price rationing system, the net benefits to each individual from the provision of the service of interest at a particular price is the sum of the excess willingness to pay at each quantity. This benefit is the area under the income-compensated demand curve less the amount paid for the good or service. These net benefits are generally designated consumer surplus and will be the benefit measure utilized here.

Consider a class of demand functions for a particular recreation site as given in Equation 1.

(1) $$V(j) = \exp(-Ł\ TC(j))\ f(Z(j))$$

WHERE

V(j) = the number of trips to the site from origin j during a given time period,

TC(j) = the total per unit (trip) costs associated with engaging in recreation at the site from origin j,

Z(j) = set of additional determinants of demand for origin j,

Ł = change in demand with a change in cost per visit ((dV/ø TC)/V(j)).

If total unit costs are proportional to distance and the proportionality factor is constant for all origin zones, then Equation 1 can be re-expressed in terms of distance. This transformation is relevant to many CORD studies, since the models have been estimated in terms of distance rather than per unit total costs. Thus assume that total unit costs are given as the sum of travel costs and time costs as in Equation 2.

(2) $$TC(j) = C \cdot d(j) + t \cdot d(j)$$

WHERE

C = per mile travel costs,

d(j) = roundtrip distance to the site from origin j, an

t = time costs per mile.

Equation 1 can be re-written in terms of distance as follows:

(3) $$V(j) = \exp(-\phi\ d(j))\ f(Z(j))$$

WHERE: $\phi = Ł(C + t)$.

The total use of a given site with given costs can then be derived by summing Equation 3 over all origins as in Equation 4.

(4) $$TU = @E\ \exp(-\phi\ d(j)) * f(Z(j))$$

WHERE the sum is over j.

Consider the effects of a change in unit costs through the introduction of an admission charge, A. The changed total use is given in Equation 5.

(5) $$DTU = @E\ \exp(-\phi\ d(j) - ŁA) * f(Z(j))$$

Since A is constant, by assumption, for all origin zones DTU can be expressed in terms of TU as follows:

(6) $$DTU = \exp(-ŁA)\ @E\ \exp(-\phi\ d(j)) * f(Z(j)) = \exp(-ŁA)TU$$

If we wish to measure the consumer surplus effects of changes in the admission fees, then we need only integrate Equation 6 over a prespecified region for A as in Equation 7.

(7) $$CS = I(\ Ł\ TU \exp(-ŁA),\ dA) = TU(1 = \exp(-ŁMP))/Ł$$

WHERE the intergral is from 0 to MP (maximum price).

It should be noted that in Equation 7 it is assumed that all other components of price remain unchanged and one considers variations only in the admission charge. Movement from $(C+t)d(j)$ to $(C+t)d(j)+MP$ represents an increase in unit costs and therefore a decrease in use (DTU) and associated loss in consumer surplus (CS).

On a per trip basis (PCS), the consumer surplus for this model is found to be a function solely of the estimated parameter, Ł, and the maximum admission charge, MP, as given in Equation 8.

(8) $$PCS = Ł - \exp(-Ł\ MP)/Ł$$

It is therefore readily computed for any given site. Since many of the CORD models are specified as in Equation 3, direct estimates of Ł are not available. Rather one must specify the unit travel and time costs (i.e. C and t). Equation 8 can be re-written in terms of ϕ as follows:

(9) $$PCS = Ł = \exp(-MP\ \phi/(t+C))/(\phi/(t+C))$$

IMPLICATIONS

The results of this derivation suggest that for a given class of demand functions it is possible to readily estimate the consumer surplus losses (or gains) associated with increases (or decreases) in the unit costs of a recreation trip that are independent of distance. Moreover, these estimates can readily be derived from estimated equations based on distance and not total unit costs provided the travel and time costs can be assumed to be proportional to distance. Since the models, in which estimates of Ł are based, have been reasonably successful in explaining visitor use patterns to Canadian Parks, the simple computational formula provided should offer a benchmark for ready calculation of the potential benefits associated reductions to user fees.

It is nonetheless true that this derivation requires a number of simplifying assumptions. Among the most important of these are the absence of substitute facilities and on-site congestion. In addition, the measure of consumer surplus are only relevant for the same dollar change in the unit costs of users at all origin zones. If the price structure changes differentially to consumers at different origin zones, then the analysis is of limited relevance.

APPENDIX

Jay Beaman and N. Hung Do

In the preceding paper a number of matters have not been carried to their "logical" end because of objects that can be raised while other considerations were not pursued because their pursuit would constitute a deviation from the main theme of the paper. Rather, it was decided to have an appendix to the paper where in a point by point way the lines of consideration that were only raised in the paper are pursued to some extent.

OBTAINING ACTUAL PER CAPITA CONSUMER SURPLUS VALUES

In the paper, formulae were developed that depend on some "highest price that would be paid". Defining such a price is important if one is using distance functions such as the inverse of distance to some power for which integrals may not converge. But for the exponential function, if MP, the maximum price, is reasonably large so that most of the area under the demand curve occurs "before" MP, then one might as well consider the results obtained by letting MP approach infinity.

If one simply lets MP approach infinity then one obtains consumer surplus, CS, as:

(A1) $$CS = \int TU \exp(-\text{Ł} A)\, dA = TU/\text{Ł}$$

WHERE the integral is from 0 to "infinity".

To obtain this on a per visit basis (PCS), one divides by TU, thus the consumer surplus is given by:

(A2) $PCS = 1/Ł$

The per capita consumer surplus for the model depends solely on the estimated parameters Ł which in reality can be interpreted as:

(A3) Ł = "resistance of distance"/cost per mile of travel

The interpretation given above is based on the fact that when one goes from a price formulation to the distance formulation which is usually used in carrying out regressions, one has:

(A4) $\exp(Ł\ A) = \exp(-l\ A/C)$

WHERE in terms of TN 14, l is the impedance of distance and where C is cost per two-way mile (further described on Figure 1). So, as described by Beaman and Lehtiniemi (see Reference 2) if one has l values such as those given in Figure 1, one can get quick estimates of per capita consumer surplus such as those shown by using:

(A5) $PCS = 1/Ł = C/l$

ARC ELASTICITY CONSIDERATIONS

One may note that with the type of demand function defined earlier, the arc elasticity of demand with respect to admission fees is less than one, or in other words reflects inelasticity. Since the arc elasticity is defined as:

$$\varepsilon = \frac{\text{Variation of demand * Average of price}}{\text{Variation of price * Average of demand}}$$

one obtains for the model:

$$\varepsilon = ((\exp(-ŁA)TV-TU/A)(((A+O)/2)(\exp(-ŁA)TU+TV/2)$$

$$= (\exp(-ŁA)-1)/(\exp(-ŁA + 1)$$

which is less than zero and greater than -1 but approaches -1 as A becomes large.

As such $|\varepsilon| < 1$ means that the demand is inelastic with respect to admission fees regardless of the value of A and Qn. This result could be considered consistent with the findings of McConnell and Duff (see Reference 40). They

report that the demand function is more elastic with respect to travel costs that it is with respect to admission charges. However, the problem is what is the elasticity with respect to travel costs? If one says that the A considered previously is travel costs rather than admission charges and they use the same demand function or introduced an AT component for

$$DTU = \exp(-Ł(A + AT))TU$$

then obviously travel and admission cost elasticities are the same when comparable charges in A and AT are considered. Only if time bias is explicitly considered (as is done subsequently) does one obtain results on which the statement of McConell and Duff can be checked.

POINT ELASTICITY AND THE MARGINAL EFFECT OF A CHANGE IN PRICE ON DEMAND

Point elasticity for the demand function defined by Equation 6 is:

$$\begin{aligned}(d[DTU]/d[A])/(A/DTU) &= -Ł\ A \exp(-Ł\ A)\ TU/DTU \\ &= -Ł\ A\ (DTU/DTU) \\ &= -Ł\ A\end{aligned}$$

However, it is considered that this negative elasticity, which goes to infinity as price is increased, is deceptive. The reason is that one should consider the following:

MC = the limit of proportional change in DTU/change in price
$= (ø\ DTU.ø\ A)/DTU = -Ł.$

The fact that MC is equal to a constant means that charging a dime more causes the same proportional change in DTU whether A has been doubled from 10 to 20 cents or increased from \$100.00 to \$100.10. This latter way of expressing how demand is changing with price is crystal clear in terms of what is meant: a certain percentage change in demand is associated with a particular change in price. What is really important to note is that because MC does not change with A, behaviourally it can be considered to reflect a person's belief that (say) 10 cents is just as important if one spends \$1.00 on a certain type of trip as if one spends \$500 on that kind of trip. Intuitively one may feel that if one was willing to spend \$500, ten cents would not mean as much as it does when it amounts to a 10% increase in trip costs. So there may be good behavioural grounds on which to object to the demand function based on the exp(-Ł D) distance function

How MC varies for other distance functions can be inferred from Figure 2 of TN 14. This is because the definition of MC here is basically equivalent to the definition of "impedance of distance", IDF(d), in TN 14.

For example the traditional distance part of a gravity function, d**a, has an impedance function (1 - a)/D which in terms of cost would imply that for people who travel further than D an added cost, such as an admission cost A, would be introduced into the denominator of the impedance function as follows:

$$MC = (1 - \alpha)/(D + A/C) \quad \alpha > 1$$

or in cost terms where A1 = CD:

$$MC = C(1 - \alpha)/(A1 + A) \text{ for } \alpha > 1$$

For this function ten cents does have less effect on behaviour when total trip expenditures are large rather than small!

From a practical perspective three points which are not introduced in more detail later show the lack of immediate importance of the issues just raised. Firstly, over the range of distance in which "trip types" can be considered constant all distance functions are fairly similar in shape and can even be considered to have "relatively constant" average impedance of distance. One can see the similarity of distance function in Figure 1 of TN 14. The problem just cited is a collinearity problem and relates to a second concern. Because of collinearity problems it is not likely that a structurally adequate trip distribution model can be identified using the data usually employed to calculate such models. Getting a correct consumer surplus depends on getting a correct model, particularly when dealing with non-isolated sites. Clearly in the context of TN 11, even if a correct percapita consumer surplus can be computed, there is a need to assess (1) to which sites it will be distributed and (2) how total visits made in a system will be influenced by the "supply generates demand" effect. The third problem is that the formulation presented is for isolated sites. To the knowledge of these authors only Knetsch and Cheung have used a systems model (albeit a rather naive one) to get a demand function for a proposed non-isolated site.

TIME BIAS

It can be noted that the demand function defined in Equation 3 has a term which relates to value of time. This is because of the problem of time bias (see Reference 9). However actually estimating time bias effects raises some interesting estimation problems. For example, the Cesario model (see TN 4) can be written as follows with hard time considered:

$$\text{(A6)} \quad V(o,d) = A(d)E(o)\exp(-\text{Ł}(D(o,d) + kt(o,d) + C(d)/c)$$

WHERE $t(o,d)$ = travel time,

$C(d)$ = admission charge, and

c = per two-way mile travel costs.

But, since using an average velocity figure, v, $t(o,d)$ can be re-written as:

$$\text{(A7)} \quad kt(o,d) = k(1)D(o,d)$$

WHERE $k(1) = kv$.

Now by taking logs of both sides of the equation, as one would to carry out a regression, one gets:

$$\text{(A8)} \quad \ln V(o,d) = \ln A(d) + \ln E(o) - (\text{Ł} + \text{Ł}\,k(1))\,D(o,d) - \text{Ł}\,C(d)/c$$

But because both $\ln A(d)$ and $\text{Ł}\,C(d)/c$ are destination effects, they can and must be combined:

$$\text{(A9)} \quad \ln V(0,d) = a'(d) + \ln E(o) - (\text{Ł} + \text{Ł}\,k(1))\,D(o,d)$$

WHERE $a'(d) = \ln A(d) = \text{Ł}\,C(d)/c$.

The parameters of an equation written in this form can usually be estimated. However, as noted, $k(1)$ cannot be determined separately from Ł so money and time costs are not separable because of collinearity. This is because, if parameters are to be estimated, there cannot be a linear relation between time bias and attractiveness that allows one to be explained by the other (the design matrix must be of full rank, see Reference 50). However from Equation A6 to A9 one sees that as long as travel time is roughly proportional to $D(o,d)$ and $C(d)$ reflects costs rather than $C(o,d)$, the terms in Equation A6 can be grouped as in Equation A9 and thus the critical time bias parameter $k(1)$ cannot be identified. Thus there appears to be little likehood of an empirical derivation of the time bias constant! In fact, in experiments carried out using a model based on Ontario but in which $t(o,d)$ was considered to be a non-linear function of $D(o,d)$ ($D(o,d)$ to powers of 1/2 to 3 were used.) So, it was still found money costs and time costs were too highly correlated to allow one to get good estimates of $k(1)$.

At least one gets Equation A9, unless a person has data on visitor use of one or more destinations for different admission fees (or if some parks charge different rates for people from different origins). Time bias (k) cannot be identified using Equation A6.

ELASTICITY WITH TIME BIAS

Earlier discussion cited a view by Duff and McConnel on elasticity. However, it was indicated that their statement lacked meaning until time bias was introduced into the demand function formulation. So now consider that the expression derived earlier means that the arc elasticities which are relevant are:

$$EA = | (\exp(-\text{Ł}\ k(1)A) - 1)/(\exp(-\text{Ł}\ k(1)k) + 1) |$$

$$ET = | (\exp(-\text{Ł}\ A) - 1)/(\exp(-\text{Ł}\ A) + 1) |$$

EA = admission charge elasticity

ET = combined time - distance cost elasticity.

Solving for the intersection of these two functions (EA = ET) one sees that for k(1) not equal to one they only intersect at zero and infinity. From the derivatives of the functions, one learns that slope of EA is less than of ET and both slopes do not change sign but go to zero as A becomes large. So it follow that as soon as A is non-zero:

$$EA < ET$$

In economic terms the preceeding means that the demand function is more inelastic with respect to admission fee than it is with respect to total travel costs. So this result is not fundamentally inconsistent with that found by McConnell and Duff. They simply stated that a decrease in demand due to the increase in travel costs is stronger than it is with the increase in the admission prices. However, one wonders if they were referring to short-term reactions to price changes rather than to the equilibrium demand elasticities computed here.

AVENUES TO PURSUE IN EXAMINING THE DEMAND FUNCTIONS VARIATION OVER TIME

When time bias is introduced into the demand function one has a demand function DTU(t) such that:

$$DTU(t) = TV \exp(-\text{Ł}\ k(1)A)$$

but as earlier Ł = l/c by the modelling assumptions so:

$$DTU(t) = TV \exp(-k(1)\ l\ A/c)$$

Given this expression one may see that:

$$\begin{aligned} P\ DTU(t) &= \text{Proportional change in } DTU(t) = d[DTU(t)]/DTU(t) \\ &= \text{Ł} \ln DTU(t) \\ &= \partial E(\text{Ł}(\ln DTU(t))/\text{Ł}(\text{parameter}))(\text{change in parameter}) \end{aligned}$$

WHERE the sum is over all parameters
$d[l]/l + d[k(1)]/k(1) + d[A]/A$

$$(A10)\quad P\ DTU(t) = (-W/c^2)\, d[c] + W(d[l]/l) + d[k(1)]/k(1) + d[A]/A$$

WHERE $W = -\,k(1)\ l\ A/c$

Or where pc, pk(1), pl and pA refer to proportional change in the paramters:

$$P\ DTU(t) = W(-(1/c)pc + pl + pk(1) + pA)$$

Equation A10 makes clear the relation between change in demand on which longitudinal information is available and other variables on which either longitudinal information is available and/or on which one may be willing to postulate what changes will be (or have been). Examination of this function for an isolated park for which use has not been altered by the creation of alternative supply could prove very interesting. In particular the equation could be important in predicting short-term response to changes in the demand function parameters because in a year or two the supply affecting most parks changes little. In the short run circumstances just indicated it is probably even appropriate to use the function to analyize changes in use of non-isolated parks as long as there is not a change in A involved that alters the role of the park with respect to alternative supply.

FIGURE 1

CONSUMER SURPLUS VALUES IN DOLLAR PER PARTY TRIP FOR DIFFERENT TYPES OF VISITS TO CANADIAN PARKS*

Consumer Surplus in $ per Party Trip	Type of Trip	Impedance of Distance (l)	Source
39.49	Main Destination Camping Trip to Camp in a Publicly Provided campsite**	.00709	Wang***
	Main Destination		
3.97	Day-Use	.0706	TN 7
4.83	Trip for Weekend	.058	TN 35
6.36	Holiday trips**	.044	TN 35
5.60		.050	TN 35
9.33	Enroute Stop-Over Camping Visit	.03	TN 18

* All computations are based on "the average party" having the belief that all relevant trip costs are such that each mile of travel costs 14 cents. Thus, c, the cost per 2-way mile (each mile must be covered coming and going), is 28 cents.

** These figures should be taken to apply to weekend and holiday trips because, even though the studies did not separate out trips after work, the number of these is so small compared to other trips that they should only cause a slight low bias in the figures presented.

*** The report is "A prediction Model for Camping Visitation", by Darsan Wang. Report 158 of Department of Tourism Recreation and Cultural Affairs, Province of Manitoba.

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A METHOD OF MONITORING PARK USE
A DISCUSSION PAPER

N.H. Coomber and J. Beaman

ABSTRACT

There have been numerous surveys carried out in which information was obtained from users of parks. This paper reports on how experience beginning with the Canadian Outdoor Recreation Demand Study park user surveys in 1968 and ending with National Park park user surveys in 1974 has prompted the development and modification of various information gathering procedures.

The report presents specifics on why certain procedures were carried out in collecting data and in weighting these data. As well there is a management perspective presented which raises questions about the need for the data that have been collected and about more efficient means for collecting information. There is an underlying theme in the paper that for efficiency there must be a concern with the objectives of collecting information and with the desired or necessary accuracy of the information to be generated from surveys. These matters must be pursued before survey work is carried out.

OBJECTIVE

This paper describes the survey methods that have been developed and used by Parks Canada during the last five years for monitoring visitor use of Canadian National Parks. In describing the strengths and weaknesses of the procedures adopted, the objective is to evoke constructive critique that will result in the improvement or replacement of the survey methods.

INTRODUCTION

In 1970, the Park Use Research Section of the Planning Division of Parks Canada embarked on a five-year research program to aid planning and managerial decision making by developing standardized and economical methods of calculating the number of visitors to National Parks and of discerning a profile of park visitors and their activities. Plans were made to begin a three-year cycle of surveys in 1971 so that by 1973 users in all National Parks would have

been surveyed. Part of the plan was to use a standard survey methodology, but major changes in the survey approach were made after the first year. This paper is particularly concerned with the surveys made in 1972 and 1973, which took place at the parks identified in Figure 1.

The objectives of the surveys were twofold. First, they were designed to obtain traffic partition rates for the park gates of the National Parks studied. These were considered very important because estimates of the numbers of park visitors in future years were to be calculated using simple traffic counts. Second, the surveys were to obtain activity and socio-economic profiles of visitors to each park for general managerial and planning purposes.

GENERAL SURVEY STRATEGY

A survey method was developed which involved speaking to persons in 'selected' motor vehicles which entered National Parks by any of the major points of entry. In 1972-3 Parks Canada's concern was with visitors entering during the peak use season of June 1 to Labour Day. Thus as selected times of selected days during this period survey stations were located as close as possible to appropriate park boundaries, and workers at these 'entrances' recorded information in the way described below.

However, before describing the general strategy, one should note that the nature of visitor traffic in National Parks (and some other matters) were the cause of a number of concerns in developing a survey design.

a. Traffic volumes varied greatly between different park gates.

b. Traffic volume varied greatly on different days of the week.

c. Traffic content in terms of, for example, the proportions of Canadian visitors in the entering traffic, varied over the summer.

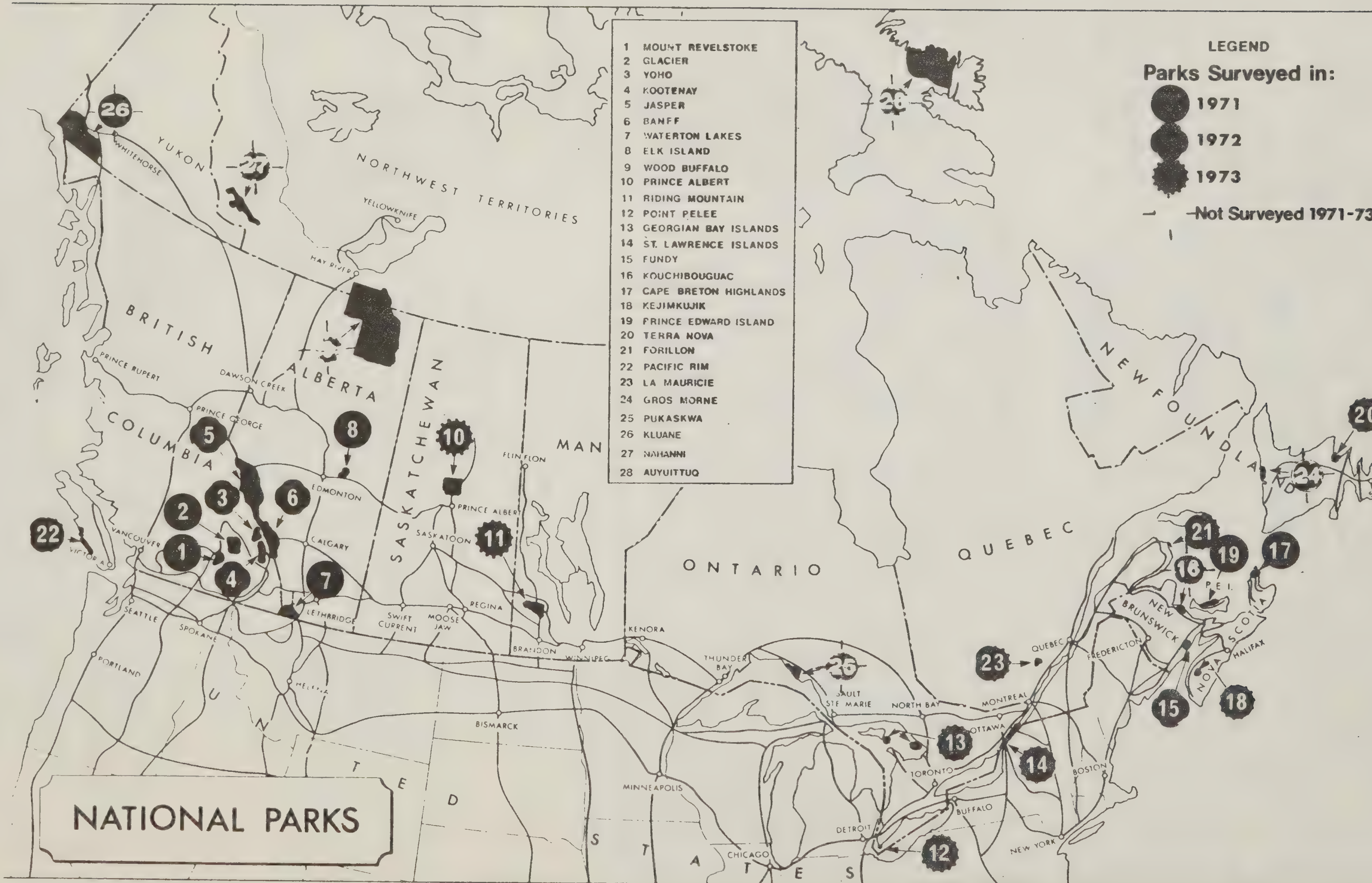
d. Information was needed on visitor use of parks outside the high-use season from July until the middle of August.

e. Traffic tie-ups at park gates were likely to occur when traffic was heavy if a high proportion of the entering vehicles were to be stopped.

f. Surveying visitors at exit points would involve problems for visitors in recalling their use of park facilities and their other activities.

Figure 1

National Park Visitor Surveys, 1971-73



g. The fact that high proportions of non-visitor traffic passed through some park gates meant that stopping a fixed percentage of incoming vehicles could result in very few contacts with visiting parties.

There was no need to stop transport trucks or other vehicles that could be identified as non-visitor vehicles. But if interviews were only conducted with passengers in every tenth vehicle who turned out to be visitors, and if only one vehicle in five contained visitors, the sampling rate would be essentially one in fifty!

Because the size of the universe of entering vehicles varied greatly at some park gates (a. and b. above) it was desirable to allow a survey crew to stop and interview as many vehicle parties as possible, but because of the inevitable problem of traffic hold-ups (e.), it was not feasible to conduct a census of entering traffic. Moreover, because of low proportions of visitor traffic to total traffic at various gates at various times, a standardized fractional sample applied to the whole park system was undesirable (g.). To avoid these problems, a sample was obtained by a procedure that involved an 'interviewer' stopping a vehicle, ascertaining specific information from the driver, 'passing' that vehicle and then stopping the next vehicle that passed the survey station that was not visually identifiable as a non-visitor vehicle. The type of sample obtained in this way was termed a 'floating' sample. It reduced the amount of time spent idle by interviewers during times of light visitor traffic, and eased traffic hold-ups at gates during heavy traffic.

Actually, the preceding description is an oversimplification of the sampling procedure. In fact, three types of records of the numbers and characteristics of visiting parties were obtained in the surveys: (1) traffic counts, (2) entry records, and (3) handback questionnaires.

Traffic count totals for each half hour on all vehicles entering each park gate during survey sessions were recorded on the form shown in Figure 2. (Fisher-Porter automatic traffic counters with a fifteen minute paper tape output have since been used successfuly in a survey of Prince Edward Island National Park. The use of these counters reduces manpower requirements in future surveys by removing the need to have a person count cars.) Vehicles which could be identified without being stopped as not containing park visitors were excluded from the count and classified as 'X' in Figure 2. This was done (1) to avoid unnecessary inconvenience to business and commercial traffic, and (2) to provide a more accurate measure of the percentage of the universe that was visitor vehicles, than could be obtained using a sampling approach. These vehicles were also ignored by the interviewer who stopped and interviewed people only in potential park visitor vehicles.

Contact between an interviewer and the occupants of those vehicles identified as containing potential park

Figure 2

Indian and Northern Affairs — Affaires indiennes et du Nord
Parks Canada — Parcs Canada

1973 PARK VISITOR SURVEY TRAFFIC RECORD
FEUILLE DE DENOMBREMENT DES VEHICULES

0 4 9 Job Number / N° de la tâche	TERRA NOVA NATIONAL PARK	PARC NATIONAL TERRA NOVA	Date
0 1 National Park / Parc national			Day / Jour
Gateway / Entrée			0 Month / Mois

Work Period / Période d'observation		Interview Period / Période des entrevues		Non-Interview Period / Période sans entrevues		Surveyor / Releveur	
Starting Time / Début	Length / Durée	Universe / Tous les véhicules	Identified Vehicles / Véhicules classés	Universe / Tous les véhicules	Identified Vehicles / Véhicules classés	No. / N°	Initials / Initiales

NPC 807N (4-73)

See instructions on reverse
Lire les instructions au verso

visitors involved the filling out of an entry record by the interviewer. Entry records were short questionnaires completed by a surveyor during short interviews with those drivers of vehicles that were flagged down and who pulled off at the survey station. Part of the interviewer's task in obtaining entry record data was to determine, by a series of questions, whether or not the party should be given a handback questionnaire.

The information requested (see Figure 3) was used by the surveyor to classify parties who were stopped and interviewed according to the purpose of their visits. Parties stating that they were entering to use facilities in the park were classified as park visitors. (Park visitors were also classified as repeat-entry visitors or first entry visitors but this distinction is not pursued here.) For these parties, the size and composition of the parties and their origin according to the vehicle licence plates were observed and noted on these forms. The driver was then asked about the party's proposed location of accommodation that night and their length of stay in the area, and the responses were recorded on the entry record. Handback questionnaires were given to these visitor parties, while for other parties only their trip purpose was recorded on the entry record.

Handback questionnaires were longer forms than entry records and were attached to the bottom of entry records which had a common serial number (see Figure 3). The 'handbacks' were torn from the bottom of entry records on completion of driver interviews and either placed in a waste bin or given to parties. On giving the handback questionnaire to park visitor parties, they were asked to have the party head complete and return it to deposit boxes situated near the park boundary beside the different roads that could be used to exit from the park. They were asked to keep the questionnaire for the duration of their visit and only return it on their final exit from the park. A mailing address was provided for respondents who omitted to do this.

The reason for the use of a handback questionnaire after an interview at the park entrance was to provide information which described the party's use of recreation and accommodation facilities in the park, their actual (rather than intended) length of stay, and their preferences for types of accommodation and services in the park (see concern (f) above and Figure 3). Having the handback questionnaire available during the entire visit to the park made it possible for parties to record information during the course of their visit, thus reducing recall problems that could have effected responses to interviews conducted with exiting visitor parties. In addition, had an exit survey been carried out:

1. There would have been logistical problems as a result of the varying length of time required to complete the questionnaires.

Figure 3

1973 PARK VISITOR SURVEY ENTRY RECORD
TERRA NOVA NATIONAL PARK

0 1 PARK

SURVEYOR'S NUMBER

GATEWAY

INTERVIEW TIME (24 HOUR CLOCK)

DAY

0 MONTH

CLASS

3 BUSINESS — 1 THROUGH TRAFFIC
5 TOUR BUS — 4 PARK VISITOR
6 COMM. BUS — 2 REPEAT VISITOR
7 RESIDENT

PROVINCE OR STATE OF ORIGIN

PARTY SIZE

ADULTS

CHILDREN

LANGUAGE

1 ENGLISH
2 FRENCH

JOB NO. 0 4 7

Nº 11314

ACCOMMODATION

1 INSIDE PARK — 2 OUTSIDE PARK–NON HOME
3 OUTSIDE PARK–HOME — 4 UNKNOWN

LENGTH OF STAY IN REGION

NIGHTS

1973 PARK VISITOR SURVEY HANDBACK QUESTIONNAIRE

Parks Canada Parcs Canada

TERRA NOVA NATIONAL PARK

Nº 11314 JOB NO. 0 4 8

PLEASE ANSWER ALL OF THE FOLLOWING QUESTIONS

1. How long do you plan to be away from home on your trip?
   Number of Nights

2. How long did your party stay in this Park on this trip?
   Number of Hours (if you did not stay overnight) OR Number of Nights

3. If you stayed overnight away from home on this trip, please indicate the number of nights spent in each of the following types of accommodation.

   Inside the Park

   Commercial Housekeeping Cottage
   Cabin Trailer
   Tent
   Tent Trailer
   Self Contained (camper truck)
   Other

   Rest of the Trip to Date

   Tent
   Tent Trailer
   Rented Cabin
   Self-Contained (Camper truck)
   Commercial Housekeeping Cottage
   Private Home or Cottage
   Cabin Trailer
   Hotel or Motel
   Other

4. Where is your present home located?

   Town or City AND Province or State OR Country other than Canada/USA

5. Which one type of overnight accomodation would your prefer to use in or near this National Park?

   1. Privately operated campground fully serviced (sewer connections, toilets, showers, food concession, etc.)
   2. Privately operated campground semi-serviced (toilets, small food concessions, etc.)
   3. National Parks campground fully serviced (sewer connections, toilets, showers, food)
   4. National Park campground semi-serviced (toilets, firewood)
   5. National Park campground unserviced or primitive
   6. Rented Cabin – no housekeeping
   7. Commercial Cabin – housekeeping
   8. Hotel or Motel
   9. Private Home or Cottage
   10. Other (please name)

6. Did you experience any difficulty in finding campground accommodation within the Park? (Please check all that apply.)

   1. No Difficulty
   2. Forced to Arrive Early (before 3 pm.)
   3. Campgrounds Full – camped in Park's overflow accommodation
   4. Campgrounds Full – will look for accommodation outside the Park
   5. Other

7. How many times did your party use each of the following Park facilities on this visit to the Park?

   Picnic Ground
   Picnic Areas
   Wayside Stop
   Viewpoints
   Serviced Beach
   Unserviced Beach
   Boat Launching, Mooring or Docking Site
   Boat Rental Sites
   Day Use Area
   Childrens Play Area
   Indoor Interpretation Centre
   Indoor Audio-Visual Theatre
   Outdoor Theatre
   Personal Contacts with Naturalist
   Exhibit Trailer
   Information Bureau
   Unguided Hiking Trails
   Guided Walks
   Boardwalk
   Guided Interpretive Trails
   Unguided Trails
   Canoe Routes
   Fishing Areas
   Campgrounds
   Wilderness Camping Areas

8. Which if any, of the following would you have used if they had been available in this Park? (Check all that apply)

   Boat tours
   "Boat only" access campgrounds
   "Bike only" access campgrounds
   Cycle trails
   Motor boating
   Ocean tour boating
   Deep-sea fishing
   Other (name)

9. If you have any comments you would like to make on your visit to this National Park, please make them below

AS YOU LEAVE THE PARK, PLEASE DEPOSIT THIS CARD IN THE BOX LOCATED AT THE PARK EXIT. THANK-YOU.

If you are unable to deposit this card, please mail to: Chief Planning Division, National Parks Service, 400 Laurier Ave. West, Ottawa, K1A 0H4

OFFICIAL USE ONLY

DEPOSIT BOX — DAY — 0 MONTH — 1 — MAIL-BACK — *FRANÇAIS AU VERSO*

NPC 518-1 (4-73)

2. Traffic problems would occur if the required number of cars was stopped at a given time in order to obtain the same accuracy as an entrance survey with about a 50% return of handback. (A survey in 1972 at Riding Mountain National Park was intended to assess the effect of non-response in creating bias, resulting in differences between entrance and exit surveys, but the need to prepare a French questionnaire resulted in data collection problems and subsequent cancellation of work on the survey.)

3. The interviewing of exiting visitors was of concern to management because of the possible reaction of some parties to being stopped when they were "all packed and raring to go".

4. Exiting parties could not be relied upon to supply surveyors with accurate information on their gate and time of entry; therefore traffic partition factors derived from exit surveys could only be used in subsequent years by taking counts of exiting traffic, instead of using the entrance data collection system presently operated by permanent staff or automatic traffic counters at most park entrances.

In order to sample as complete a cross-section of park visiting parties as possible using the 'floating sample entrance survey', the survey schedule for each gate in each Park was stratified on the basis of known variations in the content and volume of visitor traffic to National Parks at different times of day, on different days of the week, during different parts of the season. On the basis of the beginning and end of American and Canadian school holidays, which have a considerable influence on the volume and content of traffic entering National Parks, the season was divided into four parts: June 1 to June 16, June 17 to June 20, July 1 to August 16, and August 17 to September 4. On the assumption that traffic volume was higher and content more varied on weekends than on weekdays, weekends were sampled more frequently. This was achieved by dividing each week in the season into four types of day, each of which was sampled with similar frequency: Saturdays, Sundays (including holiday Mondays), Fridays, and weekdays excluding Fridays. (Defining an optimal balance in the schedule between weekend and weekday sessions depends on knowledge of traffic distributions or in theory could be achieved with a Baysian sampling approach. However, the latter would have presented severe practical problems in repeatedly changing schedules or only establishing them as data were received. Parks Canada's data for traffic distributions is being applied to optimal (cost-accuracy) Survey Strategies. See TN 19.) Because traffic also varied with the time of day, each

day was divided into two periods, mornings and afternoons. Thus, for each gate in each Park, at least one survey session in each part of day (3 parts in 1972, 2 parts in 1973), in each type of day, in each part of the season was scheduled. In scheduling any additional sessions, preference was given to gates, periods and day-types which normally experienced heavy traffic or traffic that varied considerably in content, or to periods when heavy traffic at particular gates was known to occur.

The purpose of these stratifications was to obtain sets of entry records collected during surveyed sessions which could be 'imputed' into unsurveyed sessions at the same gate because they could be judged to be similar in traffic content according to their part of the season, type of day and period of day. In other words, it was assumed that variations in traffic content were greater between these stratifications than within them, the stratifications could be used to improve the accuracy of inflating the sample to represent the universe.

On completion of the surveys, all records were returned to Parks Canada headquarters in Ottawa where they underwent manual screening and keypunching. The records were then computer-edited to check the internal consistency of all three types of record. Subsequently, traffic counts were cross-checked with the numbers of entry records in order to detect any errors which led to a larger number of entry records existing for a given half hour than were vehicles counted during that half hour survey session. Error lists were produced and corrections made, and three separate, edited and sorted files were eventually produced.

WEIGHTING

Entry Record Weighting

The first task undertaken with the entry record file was to calculate sampling rate weights for each and every half hour during which entry records were distributed. This was done in order to inflate the entry records to be representative of the universe of traffic stopped at each gate.

The size of the universe of visitor traffic during each half hour was estimated. The proportion of visitor vehicles of all vehicles which were stopped was assumed to have been the same for the total universe of vehicles which had been recorded as potential visitor vehicles. As explained above, this count had separated vehicles which could be identified without being stopped as non-park visitor vehicles, from possible or 'interviewable' vehicles. Thus, for a particular half hour survey session at a particular gate, let

u = total universe of all vehicles entering, and

x = number of vehicles identified as non-park visitor vehicles without being stopped.

Then (u-x) is the number of potential park visitor vehicles of which a certain number was stopped.

If t = total number of potential park visitor vehicles stopped

The sampling rate is t/(u-x) and thus the sampling rate weight may then be expressed as:

Sampling Rate Weight for a given gate,
for a given day,
for a given half hour:

$$\frac{(u-x)}{t}$$

It is notable that where x is large, that is a high proportion of entering traffic could be identified as non-park visitor, the sampling rate weight is more accurate than would be the case if identifiable vehicles were not counted. Thus, by identifying that part of the traffic to be stopped for interviews, greater accuracy was obtained than would be the case by taking a sample from the universe of all entering traffic.

The use of weights to inflate the number of entry records to represent the universe of visitor traffic during surveyed sessions is shown symbolically in the five figures beginning with Figure 4. In Figure 4, the shaded areas of the left-hand portions of particular periods, represented by complete cells, indicate those half hour sessions during which surveys took place. For the sake of simplicity the shaded areas are not drawn in proportion to the sizes of the samples, nor are the cells drawn in proportion to the size of the estimated universes of visitor traffic. The diagonal shading in Figure 5 shows symbolically how sampling rate weights were used to inflate the number of vehicles stopped to represent the estimated universe of visitor vehicles for each half hour surveyed.

In Figures 4 and 5 it may be noticed that there were 'time gaps' when no interviewing took place. During some survey sessions rain prevented the interviewing of entering vehicles, while sickness of survey crews or transportation difficulties also precluded a record of entering vehicles for various lengths of time. In addition, during each survey session, a meal break of one hour was taken by crews, resulting in there being no entry or traffic records for those sessions. To fill these gaps, entry records of the same day from adjacent time periods were duplicated to 'fill in for' the missing records as an estimate of what would

Figure 4
TERRA NOVA NATIONAL PARK 1973 Survey Sessions

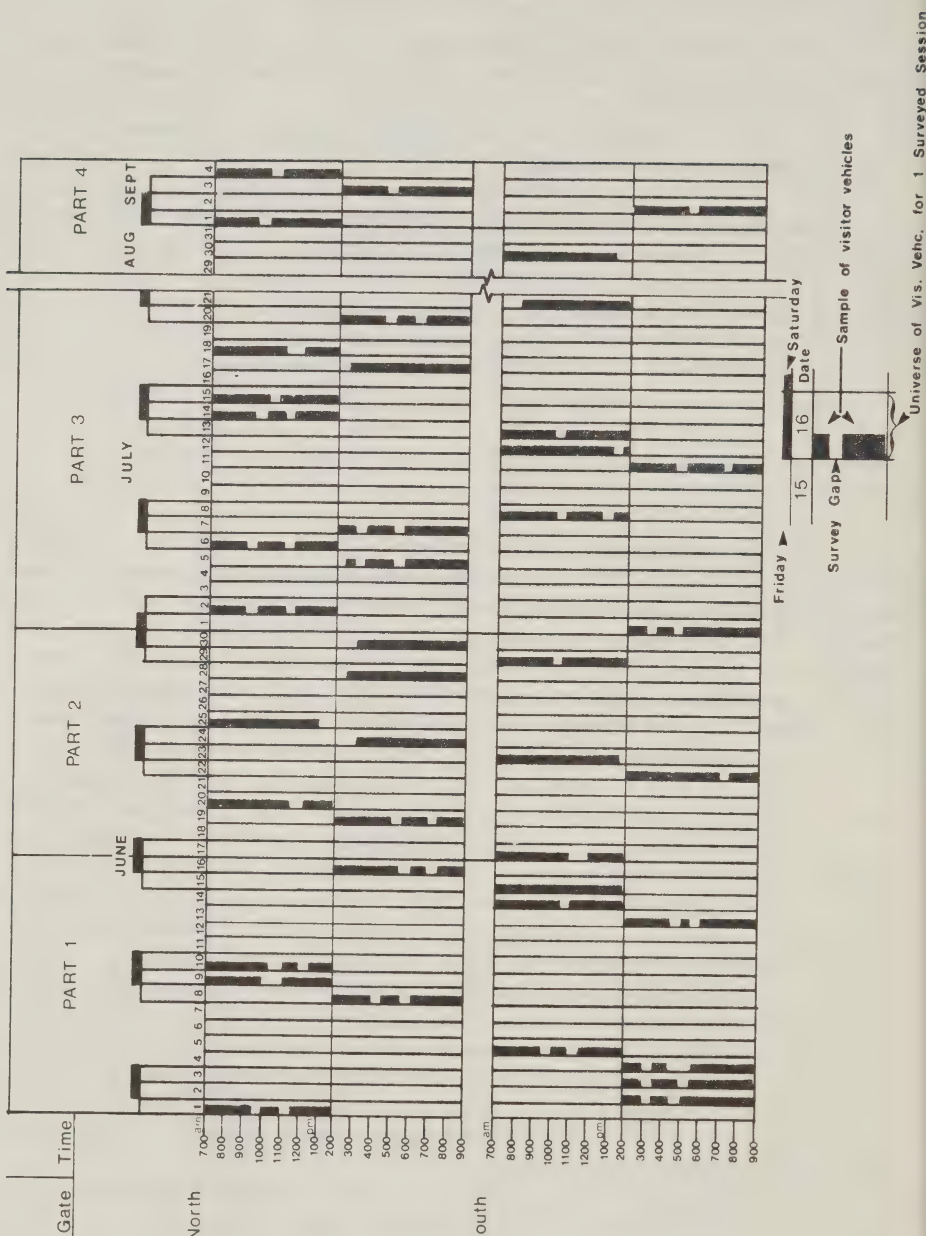
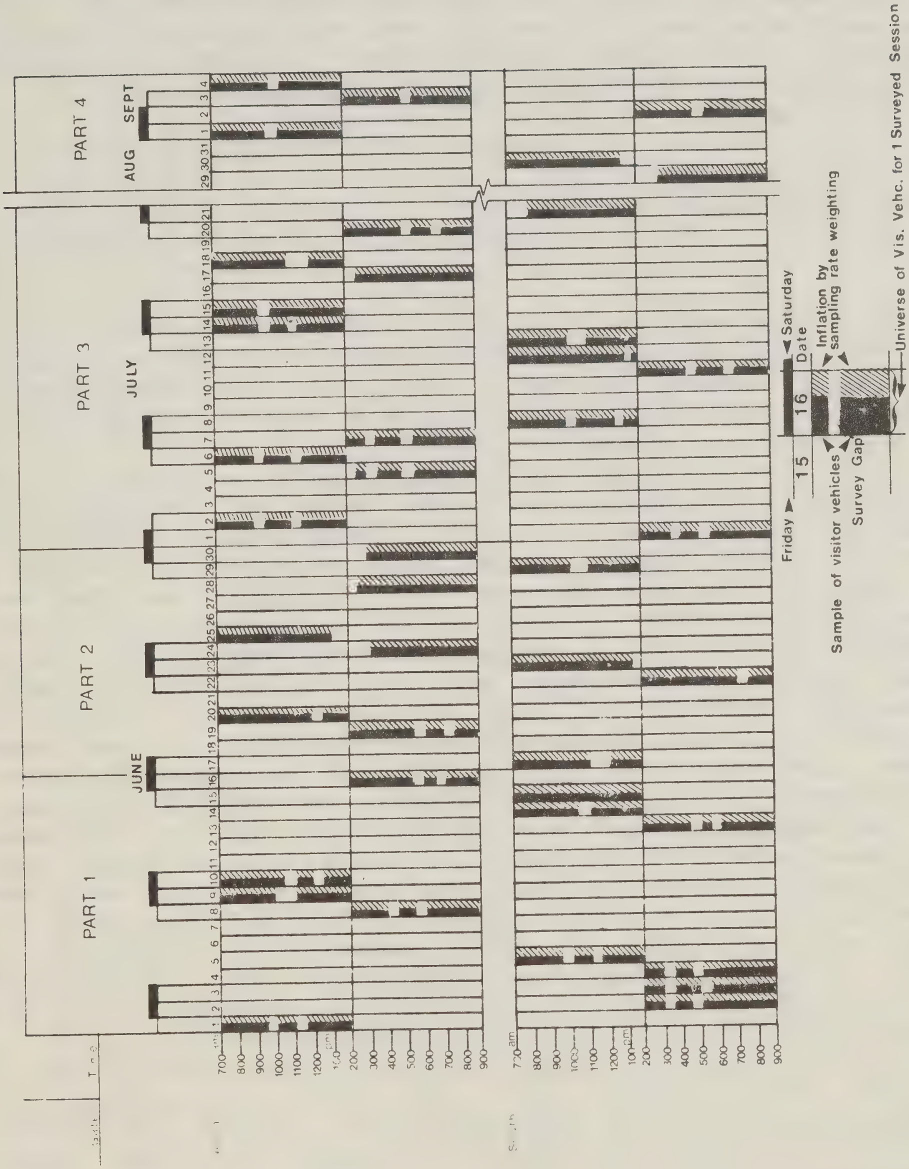


Figure 5
TERRA NOVA NATIONAL PARK 1973
Survey Sessions and the Effect of Sampling Rate Weighting



have been observed.

The actual procedure used in making these 'time fills' depended on whether or not records existed for the time periods before and after a gap. Where such records existed, the records from the preceding and following strata were duplicated. Since the length of time of the period to be filled and the 'filling' periods could differ, and typically one half hour was 'filled' by two thirty-minute periods, the sampling rate weights of duplicate records were modified by multiplication by another weight calculated as:

$$\text{Time Fill Weight} = \frac{\text{number of minutes in time period to be filled}}{\text{number of minutes in 'filling' period}}$$

When a gap occurred at the beginning or end of a day, records from the surveyed half-hour periods adjacent to it were used to fill the gap. The effects of the time filling procedure just described are shown symbolically in Figure 6 by the vertical shading.

The use of sampling rate weights and time fill weights effectively provided complete sets of records for all periods during which a survey took place. These completed sets of entry records could then be given a further weight in order to inflate the number of records, so that weighted tabulations would give correct estimates of the total numbers of visiting vehicles entering each park. The weights used to do this, with the exception noted later, were manually calculated, and thus have been called 'manual weights'. These weights were equivalent to the number of times that data for a given complete period would have to be duplicated in order to 'fill' all periods of the same type, on the same day-type and in the same part of the season at the same gate. For example, at a particular gate, there are data from a Saturday morning which was the only Saturday morning on which a survey took place at that gate in that part of the season. If there were three Saturdays in that part of the season, the weight of each record from the particular Saturday morning would be multiplied by a manual weight of 3.0. If there had been surveying on two of the three Saturdays in that part of the season, the manual weight would have been 1.5. This weighting inflated observations ot give estimates for a major part of the park visitor traffic, as shown in Figure 7 by the horizontal shading.

As Figure 7 shows, after time filling and manual weighting the only traffic for which there are not estimates occurred when, through error or logistical problems, such as sickness of crew members or rain , an entire period of a given day-type within a part of the season, which was the only period of that type missed. In Figure 7, for example, this is shown as weekday afternoons at the south gate of Terra Nova Park during part 2 of the summer. Under these

Figure 6
TERRA NOVA NATIONAL PARK 1973

Survey Sessions and the Effect of Sampling Rate Weighting and Time Filling

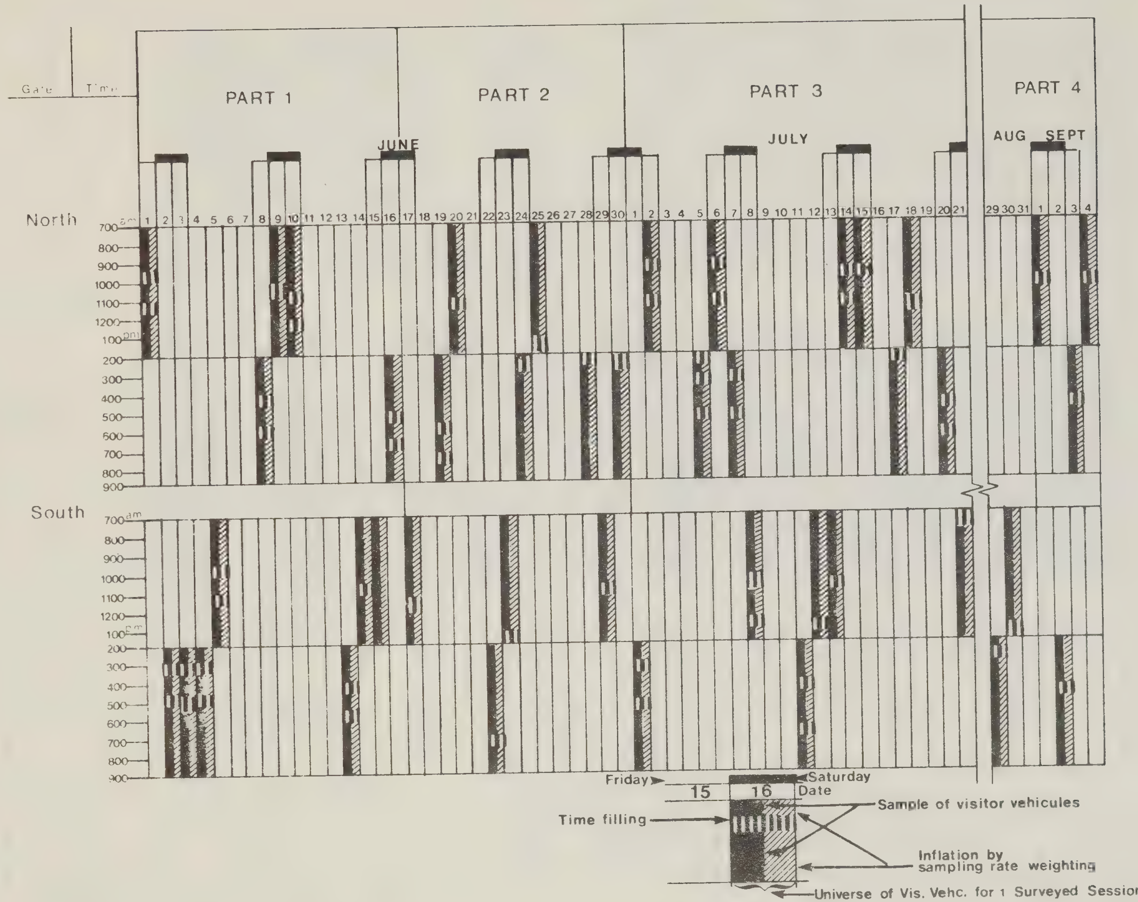
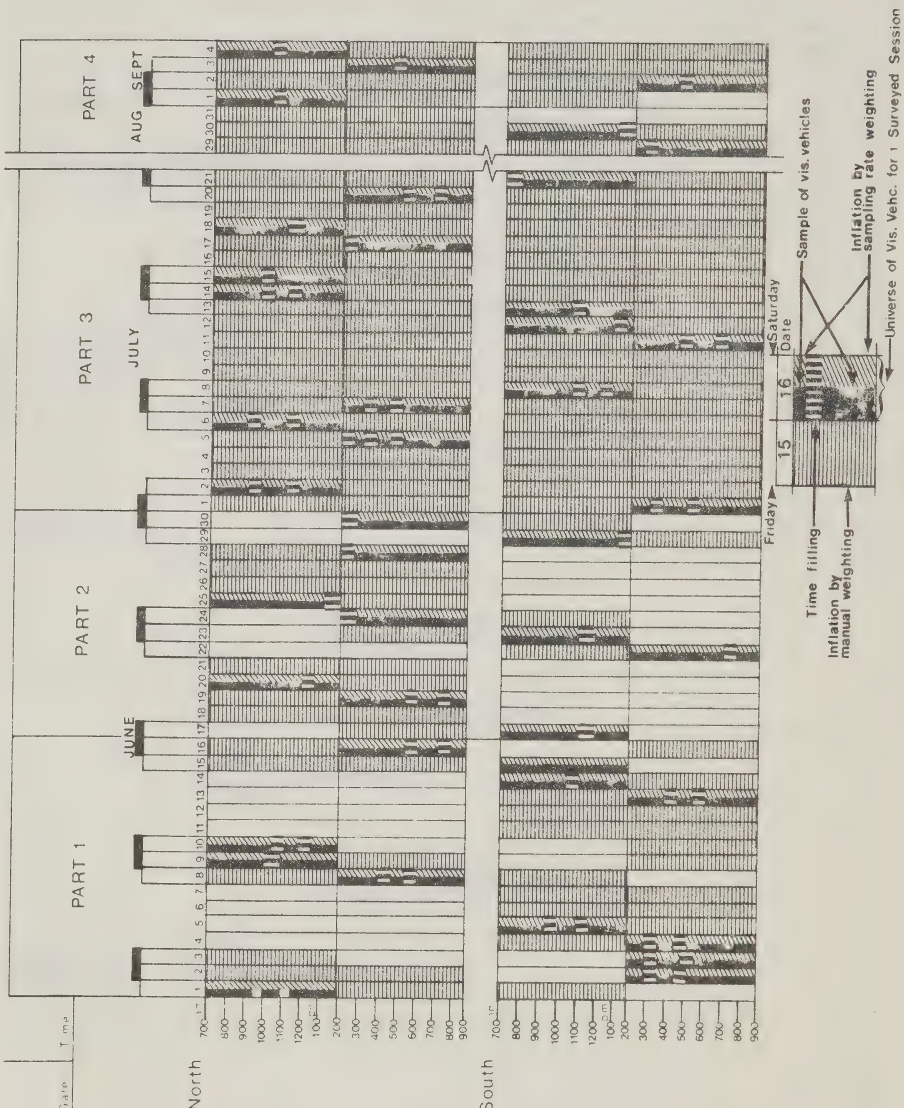


Figure 7
TERRA NOVA NATIONAL PARK 1973

Survey Sessions and the effect
of Sampling Rate Weighting
Time Filling and Manual Weighting



circumstances, 'estimates' of the missing data are created from data of the same day-type in another part of the summer which were duplicated to fill the gap. The weights on the records which were duplicated were multiplied by a 'reassignment weight' which generally reflected the different total traffic for the period with no data compared with the total traffic volume associated with the records which were reassigned. (Space does not permit the detailed explanation of how this weight was estimated; further information on this and other details may be obtained from Parks Canada on request.) Reassigned entry records were duplicated to fill missing survey sessions as shown symbolically in Figure 8 as the speckled areas. Copies of records were given the reassignment weights to correct for the different traffic volume.

The variables 'date' and 'month' were invalidated by both types of manual weighting described above. In order that tabulations of data using the variables 'date' and 'month' would not contain incorrect frequencies, the volumes of these variables were scrambled and made unavailable for normal tabulations.

Thus, at the end of the weighting process, all original entry records received a sampling rate weight, and, since no gate was surveyed on each of a particular period and type of day in the same part of the season, a manual weight. The duplication of records for time filling and reassignments was undertaken simultaneously and the weights assigned as shown in Figure 9. As the figure shows, the weight of entry records was the product of three weights if they represented entry records in a surveyed session which was reassigned to another part of the season.

Handback Record Weighting

The weighting of handback records required an additional special consideration. Since not all questionnaires for each surveyed period was returned, handback questionnaires could not be weighted simply by matching each one to its 'parent' entry record by serial number and then giving it the 'parent's' weight. This procedure could be undertaken for returned handback records, but obviously could not be used for unreturned handback questionnaires.

So, the assumption was made that the content of handback questionnaires of parties which did not respond was similar to that of similar parties which did respond. In other words, entry records with responses that were similar according to a number of criteria should, it was assumed, have 'fathered' similar handback records. Thus, entry records for which handback questionnaires had not been returned were each tested for their similarity to entry records for which handback questionnaires had been returned. Entry record 'similarity' was used as a criteria for imputing that a given handback record should be assigned to an entry record for which no handback had been returned.

Figure 8
TERRA NOVA NATIONAL PARK 1973

Survey Sessions and the Effect of Sampling rate Weighting, Time filling, Manual Weighting and Reassignments

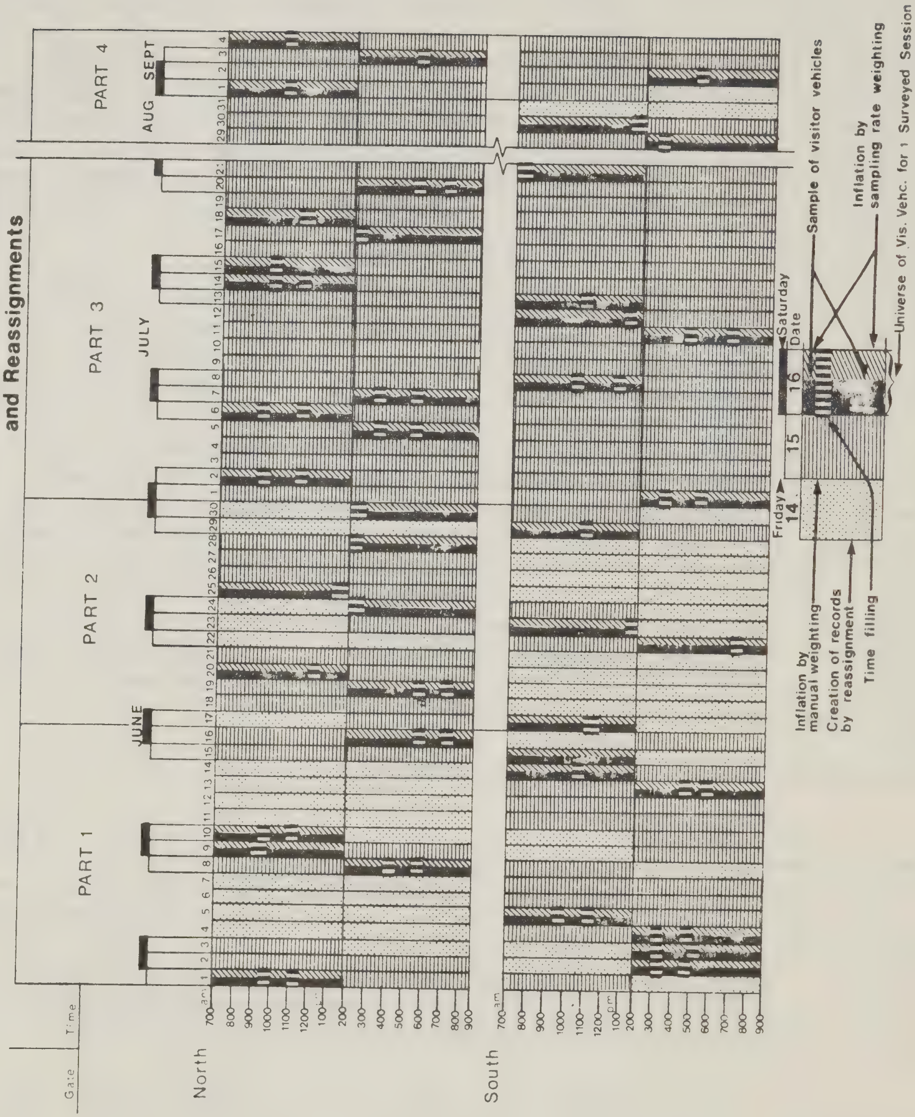


Figure 9

PROCEDURE FOR WRITING OF FILE

CONTAINING DUPLICATED ENTRY RECORDS

Original Entry Records Total Weight = Sampling Rate Weight X Manual Weight	Time Fills Total Weight = Sampling Rate Weight X Manual Weight X Time Fill Weight
Reassignments Total Weight = Sampling Rate Weight X Reassignment Weight	Reassigned Time Fills Total Weight = Sampling Rate Weight X Reassignment Weight X Time Fill Weight

(The authors' justification of this assumption is that the latent structure model of Lazarfeld and Henry (see Reference 39) that suggested that different probabilities of handing back questionnaires are associated with people in different collectivities which in this case are defined to a high degree by the entry record variables.)

To accomplish the desired matching, a file of original entry records was split into two files, one containing entry records with handbacks and the other containing entry records without handbacks. In this process, six new variables were created by arbitrarily grouping the values of the existing variables of origin, number of adults, number of children, day of week, accommodation, and length of stay. Entry records were judged to be similar if the values of the newly created variables and of several original variables matched.

The use of the newly created variables meant that entry records were to be judged similar only if they were distributed at the same gate, within an hour on the same type of day and within 28 days of each other, to parties having the same region or origin, size, number of adults, similar intended length of stay and similar intended type of accommodation. Specifically (as shown in Figure 10) in the matching procedure the original ungrouped variables were dropped one at a time from each series of comparisons of entry records with no handback and with all entry records with handback records. The number of variables dropped before one or more matches was found determined the level of match. Thus entry records with original handback records were automatically assigned a match level of 1, those matched after the relaxation of the variables 'number of children' and 'number of adults' were assigned a level of match of 2 and so on. A 'level 4 match' would occur where two entry records with the values for all variables except serial numbers, number of adults and children, day of week interviewed, and accommodation intended. When a match to an entry record was found at a given level of match, comparisons at this level were continued to the end of the file in order that additional, equally similar, matches would also be found. The matching procedure was then repeated for the next entry record with no handback and iterated until the end of the file of entry records with no handbacks was reached.

Each entry record in the file of those without handback records which was matched to one or several entry records by this procedure was then identified by its serial number and that of the similar entry record(s) with the handback records as shown in Figure 11. The number of matches and the level of match were also recorded. As shown in Figure 11, when no similar case could be found for an unmatched entry record after all the constraint rules on matching had been relaxed, a dummy handback record was created with 'missing values' of zero for each variable. In order to be able to distinguish dummy from other handback records on the final files, a level of match of zero identified dummy handback

Figure 10

IMPUTATION RELAXATION RULES

Variable Name	Imputation Level 1	2	3	4	5	6	7	8
Park *	=	=	=	=	=	=	=	=
Gate *	=	=	=	=	=	=	=	=
Area of Origin	=	=	=	=	=	=	=	=
No. of Adults - Grouped	=	=	=	=	=	=	=	=
Party Size - Grouped	=	=	=	=	=	=	=	=
Day of Week Interviewed - Grouped	=	=	=	=	=	=	=	=
Accommodation Used - Grouped	=	=	=	=	=	=	=	=
Length of Stay in Days - Grouped	=	=	=	=	=	=	=	=
Time of Survey (same half-hour)*	=	=	=	±60	±60	±60	±60	±60
Day of Survey *	=	=	=	±28	±28	±28	±28	±28
Class of Entry *	=	=	=	=	=	=	=	
Length of Stay in Days *	=	=	=	=	=	=		
Origin of Party *	=	=	=	=	=			
Accommodation Used *	=	=	=	=				
Day of Week Interviewed *	=	=	=					
No. of Adults *	=	=						
No. of Children *	=	=						
Serial Number of Questionnaire *	=							

* Original variables

records.

To make the searches for matching entry records as brief as possible the files of matched and unmatched entry records were sorted by the values of each of the variables used in assessing similarity. In this way, an entry record with no handback record would only be compared with a group of entry records having the same values of park, gate, origin code etc., and each comparison could be completed with a single pass over a small part of the file of entry records with handback records.

DISCUSSION

The following discussion focuses on five areas that require some consideration in evaluating the procedures adopted for this and other similar surveys.

Survey Biases

At least two important sources of bias are found in the survey procedure described above which require some discussion.

1. Floating Sample Biases:

Using a floating sample with half-hour time intervals, and assuming that the average volume of traffic does not change drastically during a particular half-hour, a problem regarding the randomness of observations is encountered. Changes occur in the composition of entering traffic, usually signalled by rapid change in traffic volume, e.g. from park staff driving to work to visitors, or from non-resident arrivals to the rush of local people on Friday. In half-hours where such changes take place, the low volume traffic will be over-sampled. However, this bias occurred only in a few sampled half-hour periods each year at only a few parks and is unlikely to effect the highly aggregated figures by more than a fraction.

An important problem with floating samples arises from the perpetually high probability of stopping slow vehicles that are at the head of line-ups of their own making. Such cars may be driven by the elderly, may be touring recreation vehicles, or may be slow for some other reason. A consequence of this clumping problem is that recreation vehicles travelling together, such as caravans, are likely to be subject to only one interview. However, while 'traffic volume equivalent' of the caravan would suggest a large weight for the interview, the weighting procedures will assign the caravan vehicle the same weight as a private car travelling alone.

The latter problem could be remedied by simply applying a special inflation weight to caravans depending on the number of vehicles. To prevent the bias caused by selecting cluster leaders, a survey procedure for selecting a random potential visitor vehicle in a cluster could be used.

Figure 11a

EXTRACT FROM TYPICAL WORKING FILE PRIOR TO IMPUTATION PROCESS
(sorted by Park and Serial Number)

PARK NO.	ENTRY RECORD SERIAL NUMBER	WEIGHT	HANDBACK RECORD SERIAL NUMBER
01	00567	4.5	00567
01	00568	4.5	unreturned
01	00569	4.5	unreturned
01	00570	3.0	00570
01	00571	3.0	unreturned
01	00572	3.0	00572
01	00573	3.0	unreturned
01	00574	3.0	00574
01	00575	3.0	00575
01	00576		00576
01	00		00577

Figure 11b

EXTRACT FROM TYPICAL WORKING FILE AFTER IMPUTATION PROCESS
(sorted by Park and Entry Record Serial Number)

PARK NO.	ENTRY RECORD SERIAL NUMBER	WEIGHT	HANDBACK RECORD SERIAL NUMBER	NUMBER OF MATCHES	MATCH LEVEL
01	00567	4.5	00567	1	1
01	00568	4.5	03692	1	4
01	00569	4.5	00985	1	2
01	00570	3.0	00570	1	1
01	00571	1.5	03980	2	4
01	00571	1.5	01197	2	4
01	00572	3.0	00572	1	1
01	00573	3.0	00573	0	0
01	00574	3.0	00574	1	1
01	00575	3.0	00575	1	[illegible]
01	00576			1	[illegible]
01	005			1	1

At least two advantages of a floating sample over fixed sampling rates should also be noted:

(a) surveyors used their time more efficiently than in procedures using fixed sampling rates, and

(b) the problem of traffic congestion that can be created when employing a fixed sampling rate was avoided.

2. Entrance Survey Biases:

Probably the most dependable method of checking the reliability of an entrance survey is to undertake a simultaneous exit survey and compare the results of the two surveys. As mentioned above, Parks Canada attempted to carry out such a nonresponse bias survey in 1972 in which the underlying assumption, which may be questionable, was that aggregated responses to an exit interviews would be less biased than estimates that depended on making corrections for nonresponse to handback questionnaires. It was unfortunate that it was not possible to finish this survey as a result of difficulties in printing a second set of handback questionnaires. Actually, it is likely that because of biases occurring in how people answer questions on how long their visit was, what they did when they were about to leave and other questions, both entrance and exit surveys may be biased!

It is possible, however, to identify (if not measure) three important sources of bias that occur when using handback questionnaires:

(i) The handback questionnaire may influence behaviour by providing suggestions for activities that they would not have been considered otherwise.

(ii) The handback questionnaire can be lost during a recipient's visit to a park and the longer the stay the more likely is the loss or destruction of a questionnaire. It was hoped, however, that losses occurred at a similar rate by visitors with similar entry record characteristics. Return from an exit survey are not likely to be lost. Nor, are they destroyed for any number of reasons. Reasons for nonresponse at an exit are much clearer than reasons for nonreturn of a handback questionnaire!

(iii) Multiple entry bias is created when some people enter a park many times on a simple visit while others enter only once. The latter causes a bias similar to the one that arises when a surveyor moves around a park

interviewing people at random. In the one case the visitor who enters several times has a higher probability of being interviewed in an entrance survey than the person who enters once; in the other type of survey a person's probability of being randomly selected arises in proportion of the amount of time he spends being available to be selected at random. This is, of course, controlled by only collecting data and distributing handbacks on first entry. However, a number of 'day visitors' stay in a campground just outside a park, and 'should' according to some definitions of first entry visitors, be interviewed each day while people who stay a short distance from these people, but within the Park, should only be interviewed on first entry. Do these different visitors really know what their first entry is or can an interviewer clarify this easily? Evidence from a 1974 survey of P.E.I. National Park suggests that the answer is no.

Apart from these disadvantages of using an entrance survey there are two notable advantages:

(i) People were not inconvenienced by being asked questions as they were leaving a Park but instead had a questionnaire with them while in a Park. This allowed people to use their questionnaires to record activities as they were performed, thus reducing problems of recall bias.

(ii) Even if an exit survey had been carried out using a 'floating sample', there would be little difference in the number of completed questionnaires obtained from a given input of surveyor's time. 10 minute interviews at the Park exit, instead of 5 minute interviews at the Park entrance, would have produced a similar number of records if 50% of handback questionnaires were returned, as was the case in 1973. Moreover, obtaining answers to all questions for almost all interviews is less likely to effect the reliability of results than would the inflation of 50% response to represent the universe.

<u>Survey Efficiency</u>

This paper has introduced a number of survey design and weighting considerations that should be of relevance to persons carrying out such surveys or any similar surveys of people, on foot or in vehicles, who enter a geographical area subsequently leave it. It must be recognized that the paper has not dealt with a number of important issues including:

(a) Whether a survey is the appropriate or most cost-efficient method of obtaining certain information.

(b) Why a simple random interviewing of people, for example in a camping area, is not a more effective strategy for obtaining data on park users than that described above.

(c) How to calculate the appropriate amount of sampling and the appropriate numbers of survey sessions on given day-types to achieve a cost efficient survey that, for example, has 99% probability that all estimates for the numbers of people being in certain values of 10 critical variables will be within 1% of the true number.

Much information on park visitor activities can be measured in ways other than surveys more accurately than by surveys. Campground registrations or adult and children ticket sales are good sources of data (a). (A comparison of total traffic volumes estimated by the 1973 surveys and by permanent traffic counters is shown in Figure 12.) However, when data on a party's activities in a park are to be used to analyse a park's operation, other data that presence of a party or person at a specific location are needed. Data on a person's movement within a park may be collected by the use of plastic cards similar to a credit or computerized library card (such a system as in operation on Long Island in New York State). Actually, a procedure tested at Gros Morne National Park in 1974 in a visitor survey carried out by Parks Canada involved assessing the use of a National Park by keeping a record of vehicle licence plates. Although not completely original, the success of the method suggested its extensive use in 1975. In some parks where activities are highly oriented to moving from place to place by automobile, a large amount of information can be gained from licence plates and visual observations made by surveyors of the people travelling in a vehicle or people getting into or out of a vehicle.

It is important to note that an optimal survey technique makes efficient use of time and money, and the 1972-73 strategy described above does not! As suggested in a footnote, automatic traffic counter can perform all the activities of the traffic counting member of a two-man survey crew except for counting cars that are not park

Figure 12

COMPARISON OF ESTIMATED AND OBSERVED
ENTERING TRAFFIC 1972-3

PARK	TOTAL ESTIMATED FROM PARK VISITOR SURVEYS	TOTAL RECORDED BY TRAFFIC COUNTERS	PERCENTAGE DIFFERENCE
	1972		
Banff	838,402	961,158	- 12.7
Kootenay	257,776	unknown	--
Yoho	400,985	405,559	- 1.1
Jasper	307,303	316,465	- 2.9
Fundy	174,269	171,511	1.6
	1973		
Terra Nova	159,179	not reliable*	--
Kejimkujik	38,088	41,289	- 7.8
Forillon	76,666	68,952	11.2
La Mauricie	19,665	16,372	20.1 **
Point Pelee	47,185	72,686	- 35.1 **
Riding Mountain	166,816	192,591	- 13.4
Prince Albert	43,739	48,419	- 9.7
Pacific Rim	81,347	86,959	- 6.5

* Traffic Counters were not accurately calibrated

** Large differences may be accounted for by large amounts of night-time traffic or by pedestrian or other non-vehicle traffic during the daytime.

visitor vehicles. A mechanical counter costing $2,000 (1975 price) can be set up to count traffic in one direction, to punch on tape the total traffic every 15 minutes, and to work 24 hours a day, 7 days a week with little servicing, no personnel or hiring problems, accomodation problems and so on. A survey crew member counting traffic for three months working 37 hours a week costs well over $2,000 plus expenses, and does not produce accurate data by 15 minute intervals ready to be automatically converted to punch cards and processed by a computer. The traffic counter performs more than four times the amount of counting as a crew member who works one-fourth of the hours in any week. Thus, a crew member and data processing staff can be replaced by a traffic counter and the remaining surveyors instructions modified slightly so he counts obvious non-park visitor traffic and achieves better results than in 1972-73 at a lower cost even if the traffic counter were thrown out at the end of a summer!

In a 1974 survey at Prince Edward Island National Park, where the traffic counter strategy was used, students could perform double the amount of surveying that they could using the old strategy because they did not count traffic. It was also useful for improvement of weighting to have hourly traffic data, 7 days a week all summer. Also since traffic counters can be used for other purposes during the winter and are good for 10 years cost efficiency of surveying was greatly raised.

Survey Assumptions

Having ascertained that a survey is needed and efficiently designed vis a vis (a) and (b) above and even to the detail noted in (c), there are several sources of inaccuracy in returns that result from making the assumptions that (1) all people in a party would respond in a similar manner to a question, or (2) that all the people in a party participate in the same activities, and (3) that the responses of randomly selected party members can be inflated by party size to obtain a 'universal' picture of the users' opinions or activities.

It is hoped that in making these assumptions in collecting entrance survey data and in the weighting strategy used, returns provided:

(1) Data on parties, obtained from answers to questions that could be asked of whole parties, e.g. 'How many nights did you stay at the Park?' (A not uncommon problem occurs when, for example, the husband leaves his family in a park for two weeks and visits them only on week-ends.)

(2) Answers from individuals to 'individually focused' questions. Alternatively, by obtaining a response from a random individual

in a party and data on party composition, the appropriate weighting of responses would be possible. This would provide estimates of the percentage of individuals in the universe that give a certain response.

Filling Survey Gaps

It is the opinion of the authors that there is no fallacy in the approach endorsed of filling time gaps in data to complete daily data. It might be argued that there is less chance of adequately estimating traffic for local rush hours or other periods of traffic heterogenity. However, it is more reliable to time fill from 'nearby' times of the same day rather than from identical time periods on similar days. Since the composition of entering traffic usually shifts slowly over a period of one or two hours, time filling within a day should only result in relatively slight biases particularly when gaps are filled from both sides. Given that time filling has resulted in the completion of every survey session, it is valid to assign 'manual weights' to data which reflect how often each afternoon or morning of surveying could have occurred during a given part of the summer, on a particular day type (e.g. weekday) at a particular gate compared to how often it did occur.

In addition, there is no reason why the handback imputíon procedure used should not produce results as good as or better than simple inflation in correcting for non-response (see Figure 13). Actually, since matches were not found for some records, it was necessary to inflate a number of estimates to obtain an estimate for the universe. The authors hold that it was more accurate to inflate an estimate by 10% (by multiplying the estimate by 1.11), than it was to inflate a 50% response by 2.0.

Reliability and Validity of Data

In the preceding discussion it has been noted that there has been very limited progress in assessing and understanding the reliability of estimates obtained from the park user survey, yet this field of investigation has progressed considerably compared with that of assessing the validity of such estimates. However, there persists the problem that even if we know, for example, the true number of camper nights that occurred in a park, it is not possible to discuss how an estimate of this number based on a survey reflects on the validity of the estimate unless the reliability of the estimate is known. To determine whether or not the estimate is biased, rather than whether the estimation procedure is conceptually or mathematically unsound, the reliability of an estimate must be assessed before its validity can be determined. If the reliability of an estimate is known, and if an estimate of the reliability has been made, then a statistical test can be used to accept

Figure 13

Comparisons of Original and Imputed Handback Records

(Weighted Data for all Parks surveyed in 1973)

Total Party Size	Original	Imputed
1 person	742 4.2%	775 2.4%
2 persons	6454 36.3%	13094 40.1%
3 persons	2792 15.7%	5879 18.0%
4 persons	3643 20.5%	6704 20.5%
5 persons	2039 11.5%	3805 11.7%
6 persons	1257 7.1%	1399 4.3%
7 persons	482 2.7%	530 1.6%
8 persons	192 1.1%	335 1.0%
over 8 persons	120 0.7%	122 0.4%
	17785	32648

Chi square = 562.1 with 9 degrees of freedom

Grouped Origin	Original	Imputed
Same Province	11812 66.4%	27125 83.1%
Other Province	2367 13.3%	1113 3.4%
United States	3589 20.2%	4410 13.5%
Foreign	13 0.1%	0 0.0%

Chi square = 2403.9 with 4 degrees of freedom

or reject the hypothesis that the estimate agrees with a true value. If the hypothesis is rejected, the validity of the estimate may be questioned. If the hypothesis is accepted, the validity of the estimate may be accepted conditional upon there being a chance that a more subtle analysis would show that the estimate was not totally unbiased. Thus, if a larger sample were obtained or improvements were made in weighting procedures an estimation procedure that is adequate for certain sample sizes and weighting procedures could be recognized as unacceptable when more accurate estimates can be made.

1. Validity of Entry Record Estimates

There are some data available from alternative sources that permit a cursory examination of the validity of the procedures endorsed in this paper with respect to the weighting of entry records to estimate for the universe of Park visitors. Questions asked in the survey make it possible to estimate total entering traffic for surveyed periods, which can be compared with 'observed' entering traffic counted by automatic traffic counters located near the entrances to many of the parks (Figure 12).

Unfortunately, Figure 12 may be misleading in that the totals recorded by traffic counters are not perfectly accurate. A project is under way that has shown that traffic counts at one park gate were inaccurate by 100% because of the improper functioning of a pneumatic traffic counter. It should be noted that there are many reasons for the discrepancies between counts of entering vehicles and estimates of these counts based on the park user surveys. These include such factors as:

(a) the survey only covers part of the day and night while traffic counts at almost all gates are collected over 24 hours;

(b) all traffic counts obtained by the use of pneumatic tube counters are biased by the axel count factor that must be applied to convert a raw count to vehicles. Error from this source can be high unless an extensive investigation is undertaken to provide an accurate conversion factor;

(c) where lanes are not separated, exiting traffic may be counted as if it were entering: and

(d) if either loop induction or pneumatic tube equipment is not properly adjusted it may systematically over-under-count traffic.

Thus, Figure 12 shows that there are some parks for which there is excellent agreement between estimated entry counts and counts. The recognition that no more can be said

concerning the validity of estimates and that there are serious problems with traffic counts, prompted the initiation of two projects: to derive the possible best traffic counts by analysis of all existing Parks Canada and other counts, and to examine every traffic counter's location, calibration, maintenance, and other characteristics which effect its accuracy.

2. Validity of Handback Imputation Process

The only available independent figures that are known to be accurate and can be ralated to questions asked in the survey, are those showing party nights of "developed party campground" use. Figure 13 presents estimates and observations of this figure for Terra Nova and Kejimkujik National Park based on 1973 results. A research project which is underway will produce "split sample" estimates of the variance in the estimated figures. At present it is not possible to infer from Figure 13 whether the observed differences between observations and predictions can be accepted to be due to chance or if a bias (lack of validity) can be detected.

The estimation of a campground use figure from survey results implicity tested the adequacy of the handback weighted procedure. However, unless weighting of handbacks altered the various categories of people in a way that changed estimates, Figure 13 actually shows the result of simply inflating handback results as opposed to using the imputation process. Figure 13 shows that the imputation process does in fact change estimates! It is to be hoped that this change is in the correct direction and that an advantage has been gained by imputing handbacks for the 60% of the people who did not return them. Inflating from a 46% response rate to 77% of questionnaires having handback meant that the very arbitrary assumption, that in making estimates for the universe (or same subset of it) those people who did not respond would behave like "some average person", was made for only about 24% of all records rather than for 54%.

Work is currently being undertaken to more fully evaluate the handback imputation process determining if similar entry records tend to have similar handback records. In this project, entry records with handbacks matched to an entry record are checked to see how similar are matched handbacks and how this similarity relates to what would occur by chance and by using other matching approaches. Cluster analysis and multiple discriminant analysis are being used to test the "adequacy" of matching.

ESTIMATES OF VARIANCE

The reliability of the type of survey described above was of considerable concern in Parks Canada's approach to user surveys to the extent that the design of the 1972 Park User Surveys was specified so that, sub-survey and its

replicate were built into the overall survey design. However in the end it was recognized that the incompatibility of the weighting system with the sub-survey and replicate, made it impossible to estimate variance using the original plan. Instead, the results of the entire survey were split synthetically into two sub-samples. This was achieved by randomly dividing special weighted original entry records into two files. The error estimate was calculated as a function of the difference between the total weights of the two sub-samples using the formula:

S(A)= Standard deviation for number of "X" based on entry records = |M(1)-M(2)| /2

S(B)= Standard deviation for numbers of "X" based on handbacks = |M(1)/p-m(2)/p| /2

% error = 100(1.96) S(A or B)/(estimated number of "X"s)

WHERE M(1) and M(2) are estimates of the numbers of "X" (number of visitor days, number of U.S. visitor days, etc.) and p is the response rate for handbacks for the park or park gate being considered and when 1.96 could be replaced by other values if one used to be less or more certain of estimates in the way described subsequently.

The factor p appears in the formula because the way data were processed means that estimates made using handback information indicate the number of cases on which no information was available or imputed. Then one must make the choice as to whether the wish to say that they assume the 3000 people out of 10,000 who did not respond and were not similar to other people in terms of the imputation rules, behaved like the people: if estimates should be based on dividing observed numbers by (10,000 - 3000)/10,000 = .7.

One may be interested to note some of the accuracy estimates obtained for the accuracy in numbers of first entry visitors to several National Parks. Obviously, the accuracy in estimates obtained from handbacks is only presented to show how accuracy becomes poorer when one must use handback variables (because the sample is smaller). The percent accuracy figures indicate that the predicted values have less than a 5% chance of being more in error than the value given. The numbers which follow provide a convenient guide to the highest accuracy to be expected. If one wants to know about the number of first entry U.S. visitors at Forillon for example, they are dealing with a group smaller than the universe on which there is data so the error in an estimate of the U.S. visitor can be expected to exceed 6.2%, the entry record accuracy figure given in Figure 14 (U.S. origin is an entry record variable).

Figure 14a

LEVEL OF MATCH OF IMPUTED HANDBACK RECORDS

TERRA NOVA NATIONAL PARK VISITOR SURVEY 1973

LEVEL OF MATCH \ SEASON	PART 1 JUNE 1-16	PART 2 JUNE 17-30	PART 3 JULY 1-AUG. 16	PART 4 AUG. 17-SEPT. 4	TOTAL
No Match	2158 71.2%	1432 52.5%	3308 23.2%	632 30.2%	7530 34.0%
Level 1	404 13.3%	618 22.6%	4702 32.9%	686 32.8%	6410 29.0%
Level 2	31 1.0%	65 2.4%	139 1.0%	2 0.1%	237 1.1%
Level 3	32 1.1%	34 1.2%	493 3.5%	22 1.1%	582 2.6%
Level 4	289 9.5%	379 13.9%	4017 28.1%	488 23.4%	5172 23.4%
Level 5	57 1.9%	93 3.4%	184 1.3%	57 2.7%	392 1.8%
Level 6	12 0.4%	11 0.4%	148 1.0%	30 1.4%	200 0.9%
Level 7	34 1.1%	60 2.2%	869 6.1%	98 4.7%	1061 4.8%
Level 8	13 0.4%	39 1.4%	416 2.9%	76 3.6%	544 2.5%
	3030	2730	14276	2092	22127

Figure 14b

LEVEL OF MATCH OF IMPUTED HANDBACK RECORDS 1973

LEVEL OF MATCH \ PARK	TERRA NOVA	PRINCE ALBERT	PACIFIC RIM	RIDING MOUNTAIN	POINT PELEE	LA MAURICIE	FORILLON	KEJIMKUJIK
No Match	7530 34.0%	5868 20.3%	10025 20.6%	25588 29.1%	4811 14.1%	1149 18.0%	7433 27.6%	1743 8.0%
Level 1	6410 29.0%	15465 53.4%	24715 50.8%	34905 39.7%	18554 54.3%	3508 54.9%	9415 34.9%	14382 66.1%
Level 2	237 1.1%	325 1.1%	437 0.9%	985 1.1%	472 1.4%	101 1.6%	710 2.6%	128 0.6%
Level 3	582 2.6%	365 1.1%	160 0.3%	608 0.7%	522 1.5%	73 1.1%	1052 3.9%	135 0.6%
Level 4	5172 23.4%	4724 16.3%	8968 18.4%	17071 19.4%	8645 25.3%	1504 23.5%	7188 26.6%	4096 18.8%
Level 5	392 1.8%	157 0.5%	475 1.0%	136 0.2%	163 0.5%	3 0.0%	107 0.4%	2 0.0%
Level 6	200 0.9%	415 1.4%	2411 5.0%	2834 3.2%	842 2.5%	0 0.0%	91 0.3%	544 2.5%
Level 7	1061 4.8%	1396 4.8%	1349 2.8%	5364 6.1%	145 0.4%	48 0.8%	981 3.6%	354 1.6%
Level 8	544 2.5%	222 0.8%	116 0.2%	479 0.5%	17 0.0%	5 0.1%	0 0.0%	372 1.7%
	22127	28936	48656	87969	34171	6391	26977	21757

.ACCURACY IN ESTIMATES OF NUMBERS OF FIRST ENTRY VISITOR BASED ON 1973 NATIONAL PARK USER SURVEYS

Estimates based on Park Records	Entry	Handbacks
Terra Nova	1.3	5.54
Kejimkujik	2.2	5.9
Forillon	6.2	23.7
La Mauricie	4.0	11.4
Point Pelee	3.9	12.3
Riding Mountain	1.5	11.9

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CONCLUSIONS

This paper has touched on a number of design and weighting considerations in park-user surveys. Still numerous matters raised in the sampling of relevant articles or recreation survey research given in the Appendix have not been broached. In particular, there has been a focus on a number of practical considerations that are often not recognized in survey design. In many park visitor surveys carried out today, and even in the exceptional surveys where objectives are related in a useable way to the questions asked, common problems include:

1. Results are biased in a way that is not corrected by weighting and cannot be corrected because the necessary data for weighting do not exist.

2. Inefficient use of manpower occurs in spite of high levels of skills available.

3. Results are improperly or inefficiently weighted, when often there exists readily available information that can be used to improve the accuracy of weighting.

Researchers must start to analyze their needs and find efficient ways of meeting them. If they do not take into account some of the points made in this paper, and use some of the survey techniques suggested as being practical in given situations, current problems with user research will continue. Moreover, given the growth in user research in Canada, both the number of problems and the amount of wasted resources will multiply.

Many researchers continue to believe that a planning

decision made with some information is better than one made with none. In many cases the authors could not disagree more! The use of inaccurate information in decision making, used as if it were accurate, displays either ignorance or deceit. The authors, one of whom is a statistician and the other a planner, endorse intuitive planning decisions where the data available are so inaccurate that estimates made using them fall outside the accuracy bounds desired by policy makers or planners. It is hoped that this paper will bring closer the time when decision-makers are no longer willing to accept pretentious survey conclusions or, at least, pretentious claims to providing useful planning information when the vast majority of the information provided by the researchers is either inaccurate or remains unused, or both!

Researchers recognize the need for information to aid planning decisions, but even when they are able to provide data promptly they often provide biased information that may misguide the planning of a new project, confuse the evaluation of a project, or lead to the acceptance of an unwanted policy.

In this regard the authors recommend that researchers conducting user surveys order their planning and research priorities before collecting more new information of dubious accuracy at inflated costs. It is possible today to define objectives in such a way that questions asked in a survey can meet the needs of the planners requiring the information. In the 1960's, methodological problems were necessarily 'solved' by the imperative of making some planning decision rather than none at all. The constraints of the 1970's make it necessary, and expertise makes it possible, to define objectives more rigorously. Once this has been achieved, it will be possible to accept the challenge to undertake unbiased research efficiently, and to produce accurate information while working within manpower, budgetary and time constraints.

APPENDIX

SOME REFERENCES TO USE AND USER RESEARCH THAT SHOW THE VARIETY OF PROBLEMS NOW BEING CONSIDERED

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A SCHEME FOR DECOMPOSING PARK ATTENDANCE LOADING CURVES AND RELATED ANALYSIS METHODOLOGIES

J. Beaman, and S. Smith

ABSTRACT

The development of a scheme for decomposing park loading curves (the seasonal trend of daily use) is described. This scheme allows one to estimate probable daily use of a park when one has incomplete data by extrapolating "through" the gap in existing figures. More importantly, the procedure is a useful addition to existing procedures for developing use models for parks in that it suggests a way in which a total predicted use figure for a given activity in a given park will be distributed on a day-by-day basis.

Park loading curves have been broken down into two separate curves: (1) a continuous loading curve reflecting weekday use patterns and (2) a peaked loading curve reflecting weekend and holiday use. The method is described. The reader is told such curves should be developed for specific types of users and for each park-origin pair when a model is based on survey data collected during a relatively few days. The application of the procedure to study the effects of weather on attendance patterns through analysis of residuals is discussed.

PURPOSE

The purpose of this technical note is to present a procedure developed for analyzing park use attendance curves for daily use of a park for a specific activity.

INTRODUCTION AND OVERVIEW

Decomposing the daily use curves for parks, here called "loading curves", into two components, weekday use curves and weekend (and holiday) use curves, has several possible applications. A rather simple one arises because the construction of a curve describing the general nature of the seasonal trend in attendance at a park can provide the basis for making reasonable estimates of total attendance figures for a park based on partial monitoring of use. A more important and sophisticated application is the use of the procedure to help increase the specificity and predictive

precision of use models such as the Cesario model described in TN 4. Cesario's analysis was designed to determine the factors which contribute to a park's attractiveness and the factors which contribute to the tendency of a city's population to use a park (which Cesario called "the emissivity of an origin"). If one is to learn what these various park and city factors are, which influence a certain type of park use, it is necessary to begin by stating in adequately precise behavioural terms what use of a park is being considered, what origins and population groups are potential users and what might be important to them in choosing a park and activity.

Here there is a need to break down use between weekdays and weekends. Simply applying models to total use figures for a park can lead to considerable confusion when the purpose of analysis centres on the understanding of emissiveness and attractiveness parameters. This is so because most sites serve a variety of users. An analysis of total use figures for a site results in parameters for a meaningless "average" situation (see Reference 52). If behaviour is to be accurately analyzed, it is necessary to disaggregate users of a park by type of use, time of use (weekend, weekday, holiday etc.), origin of users and possibly by several other variables. The problem of disaggregation is also discussed in TN 30 and in less detail in a number of other notes e.g. TN 14, 18, 40.

Consider for purposes of introduction a relatively isolated campground which is not being used to capacity. If this site is too distant from most of its potential users for day use, they must come on a weekend or during a holiday. The emissiveness of an origin, with respect to that park, will thus be different for weekdays than for weekends and holidays (Beaman and Leicester, see Reference 1, elaborate on the importance of time-budget constraints. See also TN 33.) Attendance curves for the use of that park over a season (loading curves) can be developed to reflect day-by-day use and will more or less resemble the curves in Figures 1 and 2. The curve in Figure 1 is more typical of an isolated park, as is evident from the great use on weekends in comparison to weekday use. Weekday use is almost negligible for most of the season. For various reasons the park with the loading curve in Figure 2 receives much more use throughout the week; some may be enroute stopover use (see TN 18) and some main destination camping use such as that for which Cesario has developed a model (see TN 4).

The basic point here is that whether a person from a given city goes to a given park on a weekday or a weekend depends on the amount of time he has available, which varies between weekdays and weekends and holidays, and depends on how far he is from the park. Persons from any given city, for a given activity at a given park, are assumed to behave according to the same kind of attendance function or pattern. So an important variable in the study of the loading curve for a given "city-park relation" is the relative amplitude of the weekend curve compared to the

weekday curve. This is a function of the distance between the city and the park, of the attractiveness of the park, and emissivity of the city for the different kinds of trips. As well, the capacity of a site is a factor to be considered. So looking again at Figures 1 and 2, two questions should be asked: (1) what causes the difference in the overall use pattern of the two parks, and (2) how is the pattern a reflection of the different perceptions of the park at different origins?

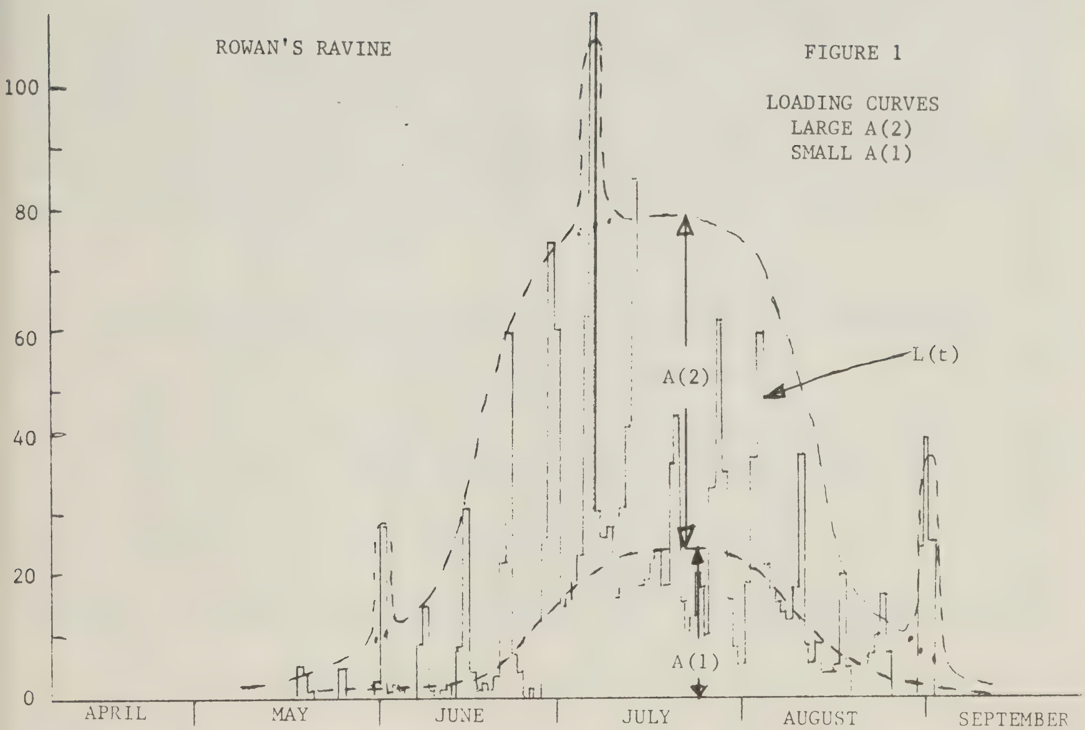
In Figure 1, for example, the relatively small amount of daily use throughout the week comes from communities which are fairly close to the park. The peaks which occur on weekends are due to an influx of visitors from slightly more distant communities. The amplitudes for these two separate components of the various origin-destination use curves can be used to develop a Cesario-type analysis for weekday and for weekend use. And, to stress a point already made here as well as in several other technical notes, such disaggregated models have greater structural validity and thus better predictive devices than an aggregate model applied to data on a given park for all origins, for use at all times of the week. Specifically, for example, it would be a mistake to use the same single-equation model to explain use for the park for which camping use is shown by Figure 1 (Rowan's Ravine) as for the park for which data are given in Figure 2 (Meadow Lake). For the majority of the readers who are not familiar with Saskatchewan parks, it is useful to note that there is little to recommend Rowan's Ravine for weekday use from fairly far away. Nor is it the kind of park that one would typically seek out for a couple of weeks of camping. It is, however, an acceptable and convenient park for a quick weekend campout. Meadow Lake Park, on the other hand, draws and holds people more for extended periods than for short weekend stays. It is distant from most origins from which users come.

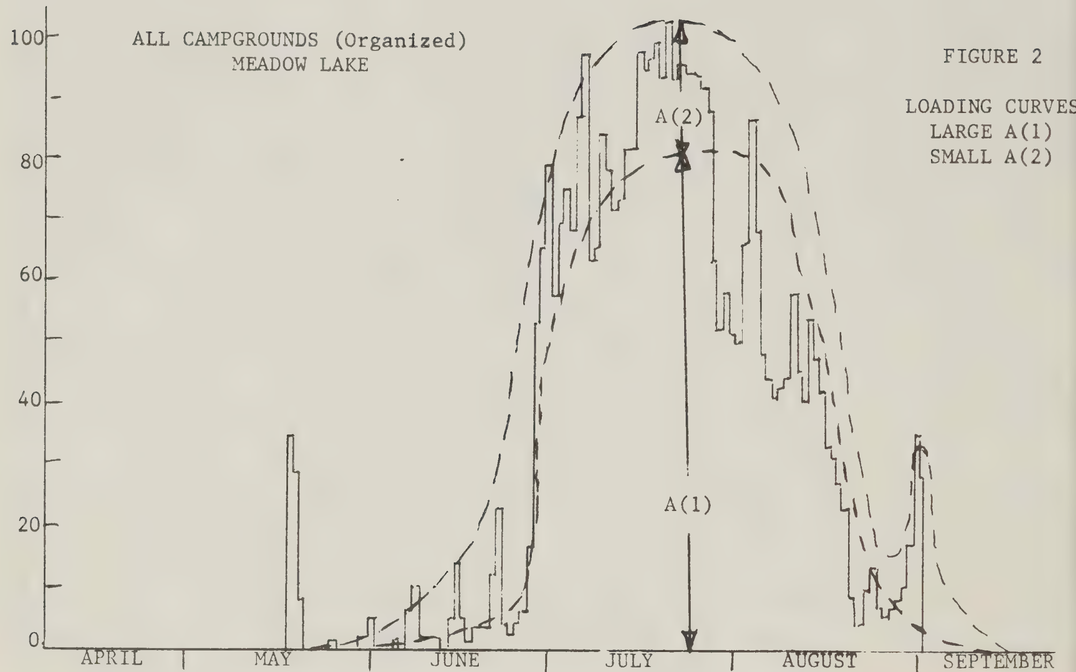
To further elaborate on the development of a loading curve analysis procedure, it is necessary to point out that here the focus is on one type of use, main-destination camping, which occurs on both weekends and weekdays. The loading curve for a park serving these types of campers for a given origin can conceivably be constructed by summing two separate curves:

(1) A continuous, smooth curve which reflects loading by main-destination campers with relatively unrestricted time-budgets (this is termed the continuous loading curve).

(2) A discontinuous, spiked curve which reflects the loading on the park by people with restricted time-budgets (this is termed the peaked loading curve).

The first curve can intuitively be considered to represent a seasonal trend in the average weekday use of a


ROWAN'S RAVINE
FIGURE 1
LOADING CURVES
LARGE A(2)
SMALL A(1)
L(t)
A(2)
A(1)
100
80
60
40
20
0
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER


ALL CAMPGROUNDS (Organized)
MEADOW LAKE
FIGURE 2
LOADING CURVES
LARGE A(1)
SMALL A(2)
A(2)
A(1)
100
80
60
40
20
0
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER

park while the peaked curve reflects attendance on weekends and holidays. A more precise definition of these curves and the method for deriving them constitute

It is important to stress that in actual planning and research problems it is essential that a set of loading curves be developed for each origin which significantly contributes to each type of use load of a park to be considered. The procedures developed and the example worked out here do not implicitly make this point clear. In fact the example presented, for reasons explained later, introduces some confusion.

Admittedly, all the disaggregation argued for in this note (breakdowns by each park in a system, each activity, each origin and time of use) will add to the number of calculations and data tabulations a researcher must handle. The authors argue, however, that unless extensive experience and testing prove otherwise, the additional work will pay off in better analyses being achieved with less data than would usually be required. Analyses should allow more valid predictions and from the insights into the factors affecting use levels the researcher should be giving useful advice to planners and policy-makers.

ESTIMATING LOADING CURVES AND AMPLITUDE PARAMETERS

Estimating The Continuous Loading Curve U(t)

Equation 1 defines the loading curve for a park as a linear combination of a continuous loading curve $U(t)$ and a peaked loading curve $P(t)$. The parameters $A(j,l)$ and $A(j,2)$, each specific to park j, determine the form of the loading curve of the park. The problem is how to derive:

$U(t)$, $P(t)$, $A(j,1,0)$ and $A(j,2,0)$ for each park-origin pair.

$$(1)\ Y(j,t,o) = A(j,1,0)\ U(t) + A(j,2,0)\ P(t)$$

WHERE

$Y(y,t,0)$ = participation at park j in the time period t from origin 0

$U(t)$ = the continuous loading curve

$P(t)$ = the peaked loading curve

$A(j,1,0)$, $A(j,2,0)$ = amplitude factors (A-factors) which are ccalculated for each park origin pair.

This representation is graphically depicted in Figure 2 which shows the addition of a peaked, discontinuous curve, $P(t)$, to form the total use curve, $Y(j,t)$.

The reader may find it desirable to assume that the bell-shaped continuous curves represent a normal curve with

the mean around July 25 (appropriate variance to be calculated). However, since "numerical methods" and computers are to be used in the analysis, no great benefit accrues from following such an approach. So to determine U(t), it was originally assumed that the loading curve for a given park was quite flat in the July 1 to August 15 period. Curves for different parks could thus be normalized so that large flows to a single park would not dictate the shape of the uniform curve, U(t), estimated. However, the results presented in TN 19 now indicate that the variance in visitor flows into a park is proportional to the size of that flow if the total flow is monitored, or to a multiple of the number of observations made if only part of the use of a park is monitored. If the concern is with day use, estimated total use and its variance are given by the formulas listed below, based on results presented in TN 19.

X = Estimated total daily use
  = 2*(Observed number of day-use parties for that day)
  = 2Y

Variance in X = 4Y

If one is considering continuous loading for overnight use and the figures being analysed are for total campground use:

$$\text{Variance in the continuous load campground use for weekdays implied} = \left|\frac{\text{Total use for weekday}}{\text{Average length of stay}}\right|^2$$

This is because total visitors/average length of stay gives an estimate of the number of entering parties. Regardless, one can suggest appropriate variance figures so that a weighted estimate of the uniform function for week days continuous use of a park for a given purpose can be derived by:

where it is a weekday; and where the sum is over a collection of parks for which these are data for the day t; and where the parks are parks that do not work at capacity on week days (or where data on a park is only included for a given day t, when it was operating at less than 90% capacity; and N(t) = estimated use of a given type; Var(t) = variance in the estimated use.

A variation of this formula was actually used in computing the results presented subsequently. An "average" curve was formed by adding up the data for all the parks considered in a given analysis. This average curve is generally irregular (due to error factors) and has gaps caused by leaving out weekend days.

The next procedure carried out was the generating of averages to fill in values for excluded weekends and for weekdays for which (by chance) there had been no

observations in any park. Gaps were first filled by inserting the average of the observation before the gap and the observation after the gap. Then a smoothed curve was to be generated. This was to be done using a 5-point running average with weights 3,5,7,5,3. But examination of the computer programme used, indicated that the weighted average was never run. Still a curve was estimated with values filled in for weekends which is the estimate of the continuous loading curve U(t) used here (see Figure 3). In intuitive terms the procedure just described is a simple averaging process.

In summary, the rationale behind what was done is that when it is assumed that all parks have a U(t) curve implicit in their loading curves, one way of estimating U(t) is to extract it. The average of all curves that contain U(t)'s is obtained in an attempt to average out "error effects" that lead to any particular park giving a poor estimate of U(t). When U(t) has been obtained for non-holiday weekdays it is possible to use estimated values of U(t)'s for weekdays to "extrapolate through" holidays and weekends. This is because U(t) is considered to be a smooth curve. In other words, use of a park on a weekend is due to the addition of an extra load or demand on top of the "average" weekday use. Finally, even after a U(t) curve has been built up, it may be expected that weather or other factors have resulted in irregularities in U(t) that should not occur. These irregularities can be removed to a certain degree by smoothing, but obviously a 5-day running average does not correct for August being a bad month all over Canada in a given year. This matter is taken up subsequently.

Estimating A(j,1,0), the Amplitude of the Continuous Loading Curve for a Park - Origin Flow (j,0)

The estimation procedure used to determine A(j,l,0) for a given park-origin park employs a least-square fitting approach where data for weekdays are fitted to the relation:

(3) Use at t from 0 to j = A(j,1,0)U(t).

The computations are carried out according to Equation 4 where the weights, W(i), reflect how much weight one wishes to put on given observations using the hand of weighting rules introduced earlier.

(4) WHERE

$$A(j,1,o) = (@E\ W(t,j,o)U(t)Y(j,t,o)) / (@E\ U(t)^2 W(t,j,o))$$

A(j,1,0) = amplitude of the continuous loading curve for park j

FIGURE 3A

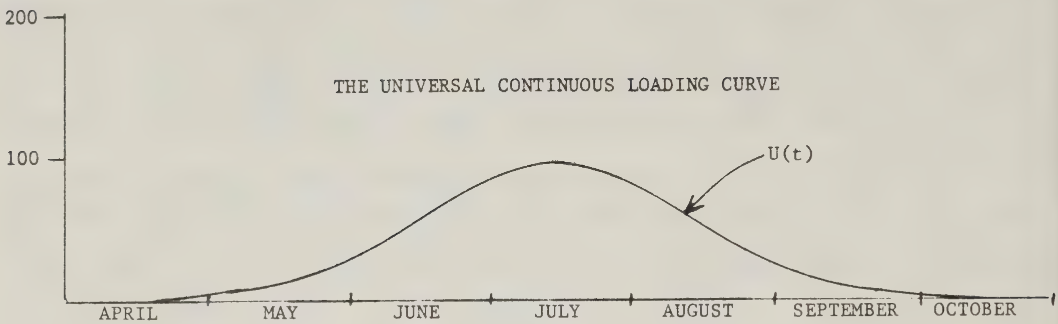


FIGURE 3B

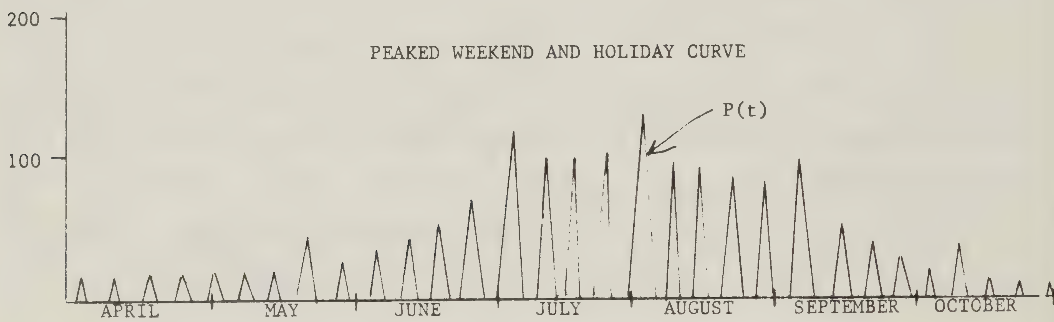
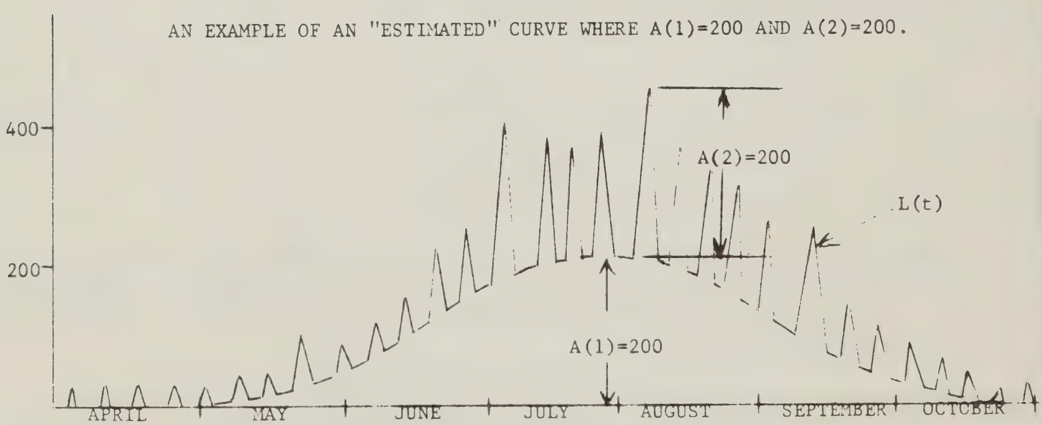


FIGURE 3C



t = weekdays for which there are data for the given park, there may be no flow from 0 to j but this just means $Y(j, t', 0) = 0$

$W(t',5,0)$ = weight to correct for varying accuracy of the estimate (Y)

$U(t)$ = the estimated continuous loading curve

$Y(j,t,0)$ = estimated use for day t.

<u>Estimating the Peak Loading Curve P(t)</u>

Given the continuous loading curve U(t) and its amplitude A(j,l) for park j, one may simply subtract A(j,l) U(t) from the observed loading curve Y(j,l) for weekend days only, to obtain an estimate of the weekend curve Z(j,t'). This relationship is expressed as follows:

(5) $Z(j,t,0) = Y(j,t) - A(j,l,0)\ U(t)$

WHERE t = a weekend day.

A procedure analogous to the one employed to derive U(t) can then be used to derive P(t), except that there is no final smoothing of P(t) and the curve is not assumed to be smooth but rather peaked and not smooth. The discontinuous function P(t) is zero, by definition, on non-holiday weekdays (t').

It may be argued that the assumption of a U(t) curve moving smoothly through weekends and holidays has theoretical deficiencies since the increased use on weekends affects the "true" continuous loading usage. However, the procedure introduced here is suggested as at least offering a good first approximation to the behavioural pattern actually involved in park use. Nevertheless, the peaked function shown in Figure 3 was derived.

<u>Estimating A(j,2), the Amplitude of the Peaked Loading Curve for Park J</u>

Given that the peaked curve has been determined from Z(j,t,0) by an averaging procedure like that described for obtaining U(t), one can use a formula similar to Equation 4 namely:

(6) $A(j,2,0) = (@E\ W(t,j,0)\ Z(j,t,0)\ p(t) / (@E\ W(t,j,0)\ P(t)^2)$

WHERE the summation is over t.

THE DATA FOR A TEST ESTIMATION AND THE RESULTS OF THE TEST

The data used in actually estimating the kinds of functions described above were from the Canadian Outdoor Recreation Demand Study's 1969 Park Users Survey. Data were collected in various parks from April to September for a total of 184 days. Analysis concentrated on main-destination campers, although of course, the procedures described here can be applied to other types of uses. Information about the CORD Study Park Users Survey is available in Volume III.

As described there numerous difficulties were encountered with the CORD Study Park User Survey both in field work and in information processing. Because of data collection problems, one should consider the estimates derived here as only illustrative of the procedures developed and not as valid predictions.

The few negative park specific peak function amplitude values in Table 1 can be called zero. One will note that these values occur for parks that essentially have no weekend peaking. On the other hand, Birds Hill Provincial Park in Manitoba and several other parks listed, in 1979, had a weekend use use amplitude over 2-1/2 times its weekday use amplitude.

DISCUSSION

Now that the method for estimating the coefficients and functions of concern here have been presented, there may still be serious concerns about the significance of the results and how to use them. One of the simplest applications of the results obtained is their use in estimating the total attendance at a park or components of this attendance. The area under the uniform curve can be determined, as can be the area under the peaked function (eg. by mechanically adding it up using graph paper). When the areas under these curves are multiplied by amplitude factors the results are total use estimates for the periods for which area was computed. This is true when the original data have been weighted and processed in such a way that they represent the universe for which totals are to be generated. All the amplitude factors do is tell a person how many times the basic area defined by the peak or the uniform function is included under the function for the particular park being considered.

If, as before it can be assumed that estimation can be carried out in such a way that multiples of the uniform and peaked function give the actual origin-specific loading curve for a park, then observations of the amount of use on certain days define the appropriate amplitudes for the peaked and uniform function. Thus there is a reversible procedure if the uniform and peaked functions are known. One can use a function that has been obtained to make estimates of use on particular days on which there were not

TABLE 1

AMPLITUDE FACTORS FOR SELECTED PARKS FROM DATA COLLECTED DURING THE 1969 CORD STUDY PARK USERS SURVEY

Province	Name of Park	A1	A2
Quebec	Bon Amie	38.73	63.08
	Mont	50.83	57.05
	Oka	48.72	34.44
	Vincennes	25.33	2.41
	Stone Ham	30.69	17.35
	Matere	17.53	6.19
	Tremblant	53.04	81.92
Manitoba	Bird Hill	51.40	135.37
	Watchorn	5.63	12.49
	Helco Island	6.54	43.03
	Rivers	12.16	53.69
	Grand Valley	24.63	-0.12
	Spruce Woods	6.21	-0.51
	Rainbow Beach	19.80	7.20
	Clear Water	2.37	-0.07
	Wekusko	2.82	-0.08
Alberta	Wabamum	41.23	22.68
	Crimson Lake	48.50	147.18
	Bow Valley	19.09	48.35
	Bragg Creek	4.97	42.05
	Willow Creek	8.03	13.92
	Beauvais Lake	6.79	63.17
	Cypress Hills	34.38	22.43
	Chain Lake	14.53	45.22
	Dutch Creek	5.81	23.15
	Lethbridge	11.73	32.88
B.C.	Bamberton Be.	26.39	30.91
	Golden Ears	7.67	441.65
	Shuswap Lake	109.97	44.16

<><><><><>

observations. However, when one recognizes the possibility of doing this one considers that if it rains on a given day or there is something else about a given day such as cold temperatures that is known then it is possible to infer that an estimate based on the uniform function would be in error. Some of the variation around an unconditional predicted

value is understandable in terms of information that is known after an event. If one knows how weather usually varies, one can see that a profile can be developed as to how use is likely to vary, for example, taking into account how weather causes the expected value to deviate. This latter matter is taken up subsequently.

For now, consider that a researcher is able to recognize a day which may be considered a typical week day or typical weekend day for the usual summer season. In the context of the preceding paragraph this day can be described as a day on which the park will have "expected attendance".

Now, consider that it is desirable to get estimates of the expected use of a park based on a minimum use of information; one can make the conscious choice to collect data on days where the expected or typical use of a park will occur. From such use data it is quite conceivable that the shape of the loading curve, actually just the peak function amplitude and the continuous loading function amplitude, can be determined very accurately, say from only two or three weekend days and two or three weekdays of observations. One is not concerned with having 20 days of data collection or some other relatively large number to be able to counter balance the effects of bad weather on one survey day and exceptionally good weather on another data collection day. Obtaining information about the effect of weather could be a separate project which could be carried out with equally small amounts of information to be used to estimate the parameters in a more generalized model (introduced subsequently). If parks are not working at capacity so that uniform loading curve appears to be appropriate for explaining use it seems clear that researchers should take advantage of similarities in the use patterns for different parks that reflect similarities in behaviour of people from different origins and minimize the manpower that (1) is tied up in collecting data and (2) is subsequently tied up in its processing, etc. The distribution of flow theory in TN 19 is relevant in determining how much data collection would be necessary to expect a certain accuracy in park use tables or other estimates to be made. Obviously, one source of systematic error that may occur when use of a park is estimated using uniform functions and peaked functions is that the representation (the model) is incorrect because the park is operating at or near capacity. Actually, the uniform function for a park could give very good results while weekend peaks could be so high that during the middle of the season the capacity of a park is exceeded so that people from certain origins do get into the park and other people from other origins do not get into the park: the people who can get there early from the close origins get in while those people who would ordinarily come to the park but would get there too late to get a camping spot do not come. However, such problems can be easily recognized as long as any kinds of decent records allow one to know if a park did operate at capacity and how frequently it operated at

capacity.

The preceding paragraphs have been explicit in suggesting that it may be possible to use the loading curve method to define some rather efficient ways to obtain information on parks and thereby to make estimates of total season use at a minimal cost. Still the authors, at this point in time, accept that this application may be questionable. Yet it is no more questionable in terms of the accuracy that will be produced than what is obtained in many costly surveys that are now carried out. Recent work at Parks Canada has confirmed that with very extensive expenditure of manpower in park visitor surveys, total use figures for many parks still have a high probability of being in error by more than 4 or 5 percent on park use totals. When one begins to disaggregate information to get origin-destination flows, user types, etc. it is possible to imagine that the accuracy figures produced from surveys involving 5 to 10 thousand interviews at a park lead to a distressing concern for the usefulness of survey results. As is indicated in CORD study Technical Note 21 there is definitely room for creative innovations in defining ways to measure park use. Whether one method or another is appropriate depends on what kind of use one is trying to monitor and one's objectives in monitoring it. If one is trying to monitor developed campground use, then campground registration forms with origin information are obviously the place to get data. Large amounts of information collected can be obtained and processed very cheaply. However, measuring day use of a park presents drastically different problems, particularly when parks have numerous entrances and numerous day use areas. In trying to assess the amount of day use in a park it may be very plausible that one of the most accurate approaches to obtaining use information and one which can involve the least manpower is to collect license plate information on cars entering a park on particular days with "expected attendance". By also obtaining information on license plates for those vehicles of people who stay in the campground it is feasible that day users' vehicles could be identified. Incidentally, as part of the visual recording of information, one can record the number of occupants in vehicles. So the use of a license technique to get day-use information in conjunction with the total or partial enumeration of users of campgrounds provides a good alternative to surveys or other methods that have been used in the past to obtain park use information. License plate data can be collected for locations other than park entrances and campgrounds so researchers not only get the usual origin-destination information but also profile information on what visiting parties have done. One test has also used the selection of plates with certain final numbers or letters to draw a manageable sample size from a large universe.

But, to return to the main theme of loading curves, there is the possibility that, for example, weather effects are being confused with errors resulting from the way the

model is specified. Although some procedures can be used to remove residuals that appear to be a result of the deficiencies of the model, this avoids the issue of why the model fails.

It may be noted that since there can be seasons or months of adverse weather, care is necessary to avoid confusing long term weather patterns with structured error.

The following discussion assumes that the residuals vary because of the influences of the weather. Consider the class of models incorporating weather factors C(j,1,t) and C(j,2,t) defined by:

(7) Y(j,t) =

C(j,1,t) A(j,1) U(t) + C(j,1,t) A(j,2) P(t) + EU(t) + EP(t)

WHERE
EU(t) and EP(t) are "error terms" reflecting "natural" variance of the continuous load and peaked load, respectively.

Also the conditions below are satisfied:

(7.1) E(C(j,1,t)) = E(C(j,2,t)) = 1

and

(7.2) E(Eu(t)) = E(EP(T)) = 0

Equation 7 implies that attendance Y(j,t) for a given park j and for a given day t, is a function of continuous load and peak load, modified by weather conditions.

The use of Equation 7 raises many issues that are not immediately obvious. If it is recognized that there can be good and bad seasons in terms of weather, the A(j,l) and A(j,2) as determined by the procedure outlined previously assume an average season (e.g. C(j,i,t) = 1 for i = 1,2) for the days surveyed. If the season was not averaged, there is an "identification problem" since the A(j,l) and C(j,l,t) become interrelated when the suggested estimation approach is employed. However, if the C-functions are known or if simultaneous estimation techniques are employed, the identification difficulty can be overcome.

Issues also arise regarding the distribution of the EU(t) and EP(t) error terms. In estimation there should at least be consideration of the variances of observations and consideration of problems introduced by serial correlation.

Regarding the C(j,1,t) and C(j,2,t) and their statistical relationship to the A-factors, one may note that the C-functions are in a certain sense random variables that fluctuate about 1.0. One way to express these variables is:

(8) $C(j,i,t) = 1 - C'(j,i,t,V(t))$ $i = 1,2$

WHERE
$V(t)$ refers to weather conditions at time t (see Reference 1).

To a good approximation one may expect that an estimation problem may be stated as:

(9) $C(j,i,t) = 1 + @E\ (B(j,i,k)\ D(j,i,k))$

WHERE the sum is on k

WHERE $D(j,i,k)$ is the deviation of weather variable k from an appropriate site specific mean based on an average season.

One may also consider partial derivatives of Equation 8. In Equation 9 the $B(j,i,k)$ are then assumed to give, at least to a good approximation, the nature of the "response surface" relating to behaviour of people in response to weather in the neighbourhood of the "average point".

A couple of closing observations about the difficulty of studying weather effects are in order. People who have come a long distance and planned to stop at a given park are not in a good position to alter their plans at the last minute because of poor weather. Parks which serve mainly as main-destination campgrounds for communities within a fairly short distance would exhibit total loading curves more directly tied to the weather. Parks which have national drawing power, however, would have loading curves not as closely tied to daily variations in weather. This emphasises the importance of disaggregating use figures by origin or type of visitor before trying to explain behaviour on the basis of use figures. From another perspective people not only respond to actual weather conditions, but also to their perceptions and anticipation based primarily on short-term forecasts of weather conditions. A forecast for a rainly weekend when in fact the weather turns out to be sunny and warm is a situation where a lower level of use than would be expected than if the forecast had been accurate.

Referring to Figures 1 and 2, the reader will notice a relative depression of use of both parks in late July and early August. Meadow Lakes exhibits a more sustained dip in attendance, reflecting its use as a long-term, main-destination campground. It is several hundred miles from large communities from which users come and few campers are likely to drive that distance when the weather has been bad and is predicted to remain so for some time. Rowan's Ravine draws campers from 30 to 40 miles away. In this case the decision to use Rowan's Ravine can be made quickly if there is a break in the poor weather for a weekend. Without belabouring this point, it should be clear that the situation of a park vis-a-vis the origins of potential campers will affect the use of that park in many diverse and

often subtle ways.

CONCLUSION

Regarding one purpose of this paper, the derivations of functions for the estimation of weekend and weekday use, one can see that establishing the kind of peaked functions and continuous functions for different parks for different origins gives one insight into the fundamentals of park use. The amplitudes of these functions are obviously better objects for analysis than total use estimates. As well, sums of such functions for various origins for a given park give a curve that can be used by planners and managers in estimating the use of a park on a daily basis. These matters relate to the general need for researchers, planners and managers to take time to develop an understanding of the components of park use figures for it is these, rather than the gross figures, which are really useful in answering research, planning and management questions. What is more, the fact that relatively limited data can be used to develop a broad understanding of general use patterns at parks makes the procedures introduced in this note not only conceptually useful but potentially analytically powerful in the statistical sense that it allows one to make efficient use of information.

CORD STUDY TECHNICAL NOTE 10

ANALYSIS OF CORD STUDY NATIONAL SURVEYS ON PARTICIPATION IN OUTDOOR ACTIVITIES TO DEFINE (1) CLUSTER OF ACTIVITIES AND (2) AGGREGATES OF PEOPLE WITH SIMILAR PARTICIPATION PATTERNS: SIMILAR ACTIVITY PACKAGES

R. Gillespie, J. Beaman, G. Romsa

AUTHORS

Authorship of this TN has been by a number of people and it is for this reason that the following notes are provided. The material presents two rather disparate points of view. Therefore the reader should note that the material on the Burton approach to analysis, which was written by Gillespie, is not necessarily accepted or condemned by other people who wrote material for other parts. Beaman wrote some of the material on cluster analysis and edited additional material on other writings by Romsa, Currie, Peebles and White. Beaman takes responsibility for his interpretation of the writings of these other authors in editing parts of their report "Recreation Activity Packages Derived From the '1969 Household Data'" into this article. However, by indicating these persons as authors, their substantial research work in deriving clusters and reporting on the derivation of these clusters is acknowledged. Peebles' work in arranging for the computer analysis to derive aggregates of people using cluster analysis is further acknowledged by presenting his discussion of cluster analysis programs only slightly edited from the way that it appeared in the original report to Parks Canada.

ABSTRACT

This TN is a straight forward document. Background information about two strategies for analyzing National Survey information are presented. In the one strategy proposed by Burton, factor analysis is used to define groups of activities. The other methodology is one for defining clusters of people with which activity packages can be associated. The paper presents the results of applying these two analysis approaches to the 1969 Canadian Outdoor Recreation Demand Study National Survey data on people's participation in outdoor activities. Results of "clusterings" by the use of the cluster analysis technique based on the information statistic (2øI) are presented. The results are for Canadian residents based on their participation in 26 outdoor recreation pursuits. The (2øI)

analysis indicates that when individuals were broken into groups based on the activities in which they participated, eight activity packages can be determined. In contrast to the results of the (2øI) analysis, factor analysis produced a number of "clusterings of activities". The clusters found allowing six factors in an oblique solution when participation in activities was analysed were described as: (1) physically active activities requiring little equipment, (2) physically passive activities with attractiveness of "general" destination areas but develops a site specific measure.

PURPOSE

The purpose of this paper is to present the results obtained when data on people's participation in activities is analyzed in two different ways, both of which have been described as giving useful information about the interrelationship between recreation activities as these relate to planning. Some would say that two methodologies that can be used to study substitutability between activities are presented.

INTRODUCTION

The Burton Method of Clustering

A general review need not be presented here of the issues that arise in relation to the analyses of peoples recreation regarding (1) substitutability, (2) equity of access to recreation opportunities, (3) the need to consider groups of people in making projections of future participation, and some other matters. These are covered in articles by Burton (Reference 7), Beaman (TN 37), Hendee and Burdge (Reference 32), Romsa (Reference 49), Beaman and Lindsay (TN 32) and in literature cited in these papers. Here, all that is important are some details about the two methods of studying substitutability actually discussed. Many of the views of Burton introduced in the following paragraphs are questioned in other works (TN 32, 37) so their presentation should not be taken as an endorsement of using the factor analysis method: the dispute is not over the general ideas but over the appropriateness of the factor analysis methodology.

Burton's analysis method may be considered to be founded on the technique of defining hierarchical groups of activities based on the participation patterns of individuals, a technique first introduced by Proctor, then extended and refined by Burton. (See Reference 7.) Taking results from 1,056 respondents, Burton applied r-mode factor analysis to their scores of participation or non-participation in various activities, thus combining the activities in question into groups of highly correlated

pursuits. According to this theoretical approach, once the groups of activities have been established and the underlying roots or characteristics of the activity group identified, a "recreation type" has been described. Burton suggests that all individuals who are closely related by their participation pattern to a certain group of activities belong to the recreation type. As an extension of the process, he suggests that the socio-economic characteristics of various individuals could be analyzed to reveal any relationships between certain variables and the recreation types of individuals.

He maintains that the definition of "recreation types" is an important step towards overcoming some of the problems associated with attempts to measure and express recreation demand in a manner which can be truly useful to the planner concerned with recreation policy, investment and facility provision. He also states that it is the kind of approach to analysis which he proposes is a basic prerequisite to any attempt to relate motivation or any other variables (as socio-economic) directly to activities.

Burton defends the view that from a practical perspective activity groupings derived from the analysis of participation data are a useful tool for planners responsible for making decisions related to the supply of facilities. He states that decision-makers can be provided with a hierarchical list of activities, with all members of a group being the most viable substitutes for other group members. Furthermore, he indicates that by comparing the groups with an inventory of existing facilities, deficiencies in the supply for certain "recreation types" can be recognized, resulting in the provision of a more satisfactory mix of facilities and activities to accommodate a wider range of participants.

It is his view that the identification of "recreation types" may facilitate the prediction of future demand for various recreation facilities. "If participation in any particular pursuit can be linked to participation in other pursuits, and to certain socio-economic characteristics, then, as the socio-economic characteristics of a given population change, it should become possible to predict, at least in general terms, how participation in given pursuits and groups of pursuits will change." (See Reference 7.) The use of activity groups is defended because "these groups serve as a more stable base for forecasting" than individual activities. This is because participation in a group is less subject to fluctuation due to change in the influential factors. If, for example, due to a change in personal disposable income, an individual changes his participation from one activity to another, it is highly probable that he will change to another activity in the same group as the first. This change then, would not affect forecasts based on activity groups as much as it would those based on individual activities, leaving the activity group method the more stable of the two. (See similar points made in TN 13, 32.)

Burton describes the activity participation approach to "recreation types" as valuable in drawing out the critical factors underlying participation in certain activities. Analysis of characteristics of campers, for example, will result in a description of campers but it will do little to explain why the people are participants in the camping activity instead of another, and how campers differ consistently and significantly from participants in other activities.

It is argued that the use of analytical techniques to form activity groups identifies the critical characteristics which make people choose among activities. The groups being established on the basis of being common choices of many individuals, the characteristics most prominent in all activities in a group are those which identify the nature of the group: that which binds it together and makes it a choice distinctive from other types of pursuits.

Table 1 is an example of the results obtained by Burton in applying factor analysis to British participation data.

TABLE 1

SOME RELATIVELY STABLE RECREATION GROUPS

Group I	Group II
Soccer	Roller Skating
Cricket	Ice Skating
Table tennis	Youth Club
Tennis	Horse riding

Group III	Group IV
Rugby	Picnicking
Athletics	Driving in the countryside
Cycling	Gardening
Basketball	Dining out
Keep Fit	
Badminton	

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The Clustering of Individuals: A Second Analysis Approach

The preceding has introduced the reader to one perspective on how the inter-relationship between activities can be considered quantitatively so that results obtained allow one to take into account the inter-relationships

between activities when one plans for facilities, programs etc. The perspective concentrates on activities and intercorrelations between participation rates in different activities. A different approach to the problem concentrates on a similarity between people. In the remainder of this paper the work by Burton is referred to as defining clusters of activities whereas the use of cluster analysis (as described below) is referred to as producing groups or aggregates of people. It is said that these groups are defined on the basis of the activities in which members of an aggregate participate.

The conceptual model behind this second perspective is that people naturally divide into groups on the basis of the activities in which they participate. The focus of attention is not on the interrelationship between activities but rather, in terms of the way some analysis programs work, on defining which people are alike according to the activities in which they participate.

From a practical point of view one may consider that if there is information about an individual that gives the number of times he participated in each one of a number of activities during a given year, this person can be compared with other people. Let us say that for each activity a person categorizes the participation information to indicate that he did not participate, participated a little bit, was a fairly regular participant or was a frequent participant.

One may proceed to define a way in which a person's "status" in terms of these categories of participation in various activities may be used to compute a "distance" between individuals. Obviously one of the simplest ways is to give the level of participation categories a value between 1 and 5 and then simply compute distance by taking differences between category values, between two individuals on an activity, by activity basis, squaring these differences and adding them up as indicated below:

distance X to Y = @E ((score for individual X for activity a)
                  − (score for individual Y for acitvity a))^2

WHERE summation is over all acitivities.

Though there are numerous reasons to criticize such an ad hoc approach to defining a distance function (or metric), the reader is asked to consider that something like this is what could be done in defining distances between individuals. Then, with a measure of distance computed between every individual, the clustering of individuals problem becomes putting those individuals who are "close" together into groups. This is what one may visualize cluster analysis programs as being about (the reader interested in a more sophisticated discussion should see the appendix to this Note and the literature cited there).

When a person has either manually (see Reference 28) or by a computer sorted out the people in a universe into clusters (aggregates), one can see from the way that the

clustering has been done that clusters are aggregates of people who are relatively homogeneous in their behaviour in terms of the activities in which they participate. Of course this is homogeneous in relation to the way that a particular distance function was defined and on the distance between individuals. When using this type of clustering, rather than obtaining a group of intercorrelated activities (activities with a high factor loading on a given factor) as the first analysis output, cluster analysis as described here produces groups of people with whom a collection of activity may be associated. It is this collection of activities in which these people in a particular aggregate participate that here is called the activity package of the people in a particular aggregate.

THE DATA

The data used in this study were the 1969 CORD Study data on Canadian's participation in outdoor activities. Details on the data collection, editing etc. are given in the CORD Study Data Documentation Volume. In summary, 3000 interviews were carried out with people resident in Canada. The data shown in Table 1 were collected with information on participation for the year preceeding November 1969, which is when the interviews were carried out.

It would be nice to be able to claim that the sample was a random sample of Canadians 18 and over, but this is not quite the case. Sampling proceeded in such a way as to yield a random sample until an exact interview location was selected. The manner of chosing an interview location and the manner of selecting individuals after that (including the use of replacements for non-response and sampling quotas, and not at home weighting) result in a sample that, at least technically, is not a random sample. Still, comparison of weighted survey results with the census show good agreement on comparable variables.

One paper has been written (see TN 24) commenting on the reliability and validity of the data collected in the survey of 1969 and similar surveys in 1967 and 1972. The reader may find the results presented there to be of some interest as they show possible large discrepancies between independent studies. One may also wish to compare the similar survey of 1972 with Ontario Household Survey (see Reference 44) results. This shows good agreement between a much better designed and executed survey.

DEFINITION OF ACTIVITY PACKAGES USING FACTOR ANALYSIS

Factor analysis can be used in data analysis for a variety of purposes but in this application, the object is to identify an underlying pattern of relationships suggested by the correlations between a collection of variables. Veldman (see Reference 59) explained how, "in some situations, factor analysis may be considered a procedure

for exposing the essential, determining constructs behind a set of observable behaviours", but here factor suggests an abstract "form" of recreation behaviour (see Reference 4).

The explanation of the mathematical principles and operations on which factor analysis is based is a fairly complex task, and it is not really appropriate or feasible in this paper (see Reference 29). However, it is necessary to comment on the technique of rotation. The factors extracted initially by most factor analysis programs are orthogonal: that is, they are uncorrelated or, represented graphically, they are at ninety degrees to each other. The first factor defines the most important underlying dimension (in terms of the percentage of variance explained); the second factor is the next most important dimension orthogonal to the first, and so on. However, the resulting structure of factors is not statistically unique and can be transformed, rotated, into many equivalent definitions of the underlying dimensions all of which explain just as much variance. Infact, sometimes it is desireable to depart from an orthogonal solution to an oblique one. Such a solution often has factors which are composed of more closely-correlated variables, although 6 factors are no longer totally independent from each other.

When the factor analysis procedure proposed by Burton was applied to the Canadian Outdoor Recreation Demand Study data described above, activity packages such as those presented in Tables 2 through 7 were derived. The selected results summarized here represent 5 and 6 factor orthogonal solutions to the 26 activity set (Tables 2 and 3), a 6-factor obliquely rotated solution based on 26 activities (Table 4), and a 16-factor orthogonal solution based on 78 activities representing different levels of participation in the original 26 activities (Table 6). In the 78-activity set, for example, "swimming No. 1" represents the "0-5" level of frequency of participation while "swimming No. 2" represents the "6-10" level of frequency of participation, and "swimming No. 3" represents the "more than 10" level.

TABLE 2

Factor Analysis Groups Based Upon 26 Activities and 5 Orthogonally Rotated Factors

Factor I (Group I)	Factor Loading
Sightseeing	.63
Other Park Use	.61
Historic Sites Use	.59
Picnics	.47
Pleasure Driving	.41
Swimming	.30
Photography	.28
Snowmobiling	-.03
Snow Skiing	-.01
Hunting	+.01

Factor II (Group II)		
Water Skiing	.57	
Snow Skiing	.47	
Power Boating	.46	
Canoeing	.41	
Tennis	.40	
Sailing	.38	
Golfing	.31	(2)
Swimming	.31	(2)
Horseback Riding	.28	
Pickup Camping	-.01	
Picnics	-.01	

Factor III (Group III)	Factor Loading
Ice Skating	.51
Snow Sledding	.49
Bicycling	.46
Swimming	.31
Horseback Riding	.28
Sightseeing	.01
Nature Study	.01
Sailing	.02

Factor IV (Group IV)	
Snowmobiling	.43
Hunting	.32
Tent Camping	.25
Trailer Camping	.29
Pickup Camping	.16
Tennis	-.07
Sailing	-.00

Factor V (Group V)	
Nature Study	.43
Pleasure Walking	.35
Climbing	.34
Photography	.27
Ice Skating	-.05
Water Skiing	-.04
Snowmobiling	-.02
Power Boating	-.02

Notes: Weakly or negatively associated activities below double lines. Factor Loading rank in parentheses for activities listed in more than one group.

TABLE 3

Factor Analysis Groups Based Upon 26 Activities and 6 Orthogonally Rotated Factors

Factor I (Group I)	Factor Loading
Sightseeing	.63
Other Park Use	.60
Historic Sites Use	.58
Picnics	.47
Pleasure Driving	.43
Swimming	.33
Photography	.29
Snowmobiling	-.01
Snow Skiing	-.00
Canoeing	.02
Horseback Riding	.03
Playing Tennis	.03

Factor II (Group II)	Factor Loading
Water Skiing	.55
Snow Skiing	.47
Playing Tennis	.44
Power Boating	.41
Canoeing	.40
Sailing	.37
Golfing	.32
Horseback Riding	.30
Swimming	.28
Picnics	-.01
Pickup Camping	-.01
Pleasure Driving	-.00
Trailer Camping	-.04
Nature Study	-.04

Factor III (Group III	Factor Loading
Ice Skating	.50
Snow Sledding	.49
Bicycling	.47
Swimming	.32
Horseback Riding	.28
Sailing	.00
Sightseeing	.01
Nature Study	.02
Trailer Camping	.02
Pickup Camping	.03

Factor IV (Group IV)	Factor Loading
Power Boating	.47
Snowmobiling	.45
Hunting	.29
Playing Tennis	-.09
Other Park Use	-.06
Sightseeing	-.03
Historic Sites Use	-.03
Climbing	-.01

Factor V (Group V)	Factor Loading
Nature Study	.44
Pleasure Walking	.36
Climbing	.33
Photography	.27
Ice Skating	-.05
Water Skiing	-.03
Golfing	.00
Pickup Camping	.00
Snowmobiling	.01

Factor VI (Group VI)	Factor Loading
Pickup Camping	.38
Trailer Camping	.31
Tent Camping	.26
Sailing	-.73
Swimming	.00
Pleasure Walking	.00
Nature Study	.01
Ice Skating	.02

Notes: Weakly or negatively associated factors below double lines.
Factor loading rank in parentheses for activities listed in more than one group.

TABLE 4

Factor Analysis Groups Based Upon 26 Activities and 6 Obliquely Rotated Factors

Factor I (Group I)	Factor Loading
Ice Skating	-.59
Snow Sledding	-.54
Bicycling	-.49
Playing Tennis	-.47
Swimming	-.45
Horseback Riding	-.39
Pickup Camping	-.04
Trailer Camping	-.06
Nature Study	-.07

Factor II (Group II)	Factor Loading
Sightseeing	.64
Other Park Use	.62
Historic Sites Use	.61
Picnics	.51
Pleasure Driving	.44
Swimming	.37
Photography	.33
Snowmobiling	.02
Hunting	.04
Snow Skiing	.05
Canoeing	.06

Factor III (Group III)	Factor Loading
Water Skiing	-.60
Power Boating	-.57
Snow Skiing	-.49
Canoeing	-.45
Swimming	-.39
Sailing	-.37
Golfing	-.32
Hunting	-.24
Picnics	.09
Pleasure Driving	.09
Other Park Use	.08
Trailer Camping	.07
Pickup Camping	.01

Factor IV (Group IV)	Factor Loading
Snowmobiling	.43
Power Boating	.36
Hunting	.26
Playing Tennis	-.12
Sailing	-.03
Climbing	-.01
Other Park Use	.00
Golfing	.01
Historic Park Use	.01

Factor V (Group V)	Factor Loading
Pleasure Walking	.47
Nature Study	.46
Climbing	.41
Photography	.38
Pickup Camping	.03
Hunting	.07
Snowmobiling	.07
Trailer Camping	.07

Factor VI (Group VI)	Factor Loading
Pickup Camping	-.37
Tent Camping	-.34
Trailer Camping	-.33
Hunting	-.23
Sailing	-.01
Nature Study	-.07
Pleasure Walking	-.11

Note: Weakly or negatively associated activities below double lines. Factor loading rank in parentheses for activities listed in more than one group.

TABLE 5

Correlations Among 6 Obliquely Rotated Factors Based Upon 26 Activities

Factor (Group)	I	II	III	IV	V	VI
I	1.0					
II	- .20	1.0				
III	- .43	- .11	1.0			
IV	- .18	.11	- .15	1.0		
V	- .32	.36	- .20	.05	1.0	
VI	.23	- .22	.21	- .23	- .17	1.0

The method of determining which groups an activity should belong to was necessarily fairly subjective. In the formation of activity packages, each variable or activity was placed in the group (factor) on which it had its highest loading. Not all activities, however, loaded strongly on only one factor. Because some activities are associated with the underlying dimensions of more than one activity group, they loaded moderately on the factor for all these particular groups. In order to give recognition to all the dimensions of all activities, those which are "closely" related to more than one factor were placed in all those groups. In the tables, activities with multiple group membership have the rank of their loading indicated in parentheses. For example, see Swimming in groups I, II and III in Table 4. In rare cases, where an activity loaded very high on a factor to the point where it would be an important group member, but loaded much higher still on another factor, it was placed in both groups. See, for example, Power Boating in groups III and IV in Table 4.

Just as the highest loading activities on each factor can be used to describe the characteristics of that group, so can the lowest loading activities. These most weakly associated or even negatively associated activities may be thought of as not possessing the characteristics represented by the activities included in the factor or, if loaded negatively, they represent the antithesis of what the people who score positively on the factor like. In the case of the 78-activity set described subsequently, where each of the original 26 activities is represented at three different levels of participation, each individual can only participate at one level ($3 \times 26 = 78$). If one is recorded as participating at the Swimming-3 level, for example, he cannot be a participant in Swimming-1 or Swimming-2. Therefore, for any given activity of the 78, the most negatively associated activities will be the other two levels of the same activity. In interpreting the group characteristics through the lowest or negatively loaded activities, the other levels of any group member are, therefore, ignored.

As stated above, many alternative "solutions" to the problem of extracting the underlying dimensions in the data were developed for both the 26 and 78 activity data sets. Only a summary of results is presented in this paper. The choices of the type of analysis applied (othogonal or oblique), and the number of factors in the accepted solution, were based on an attempt to derive activity groupings which were both statistically viable and analytically meaningful.

To determine the most acceptable solution, then, for each activity set, all solutions for that set were compared on the basis of four tests. First the "reasonableness" of each activity grouping in the solution was considered to determine in which solution the activities of each group were most closely related in terms of associated characteristics such as cost of participation and

relationship to nature. The second test, which was also subjective, involved a consideration of which solution was most representative of all the solutions for the particular activity set.

The final two tests concerned the statistical properties of the solutions. Test three was a consideration of the eigenvalue of each factor in a solution, or the amount of variance explained by a factor relative to the original variables. A factor with an eigenvalue of less than 1.0 has weaker power of explanation than one of the original variables. The final test was the percentage of total variance explained by the various solutions.

Of all the different factor analyses performed on the 26 activity set, the obliquely rotated 6 factor solution (Table 4) was the most acceptable. Strictly on the basis of reasonable groupings, all solutions were fairly acceptable. Indeed, the groupings were so stable throughout the various solutions that there were only minor distinctions between solutions on both criteria of reasonableness and representativeness. The 5 and 6 factor orthogonal solutions (Tables 2 and 3) were almost identical except for the combination, almost intact, of two groupings. Because both groups consistently appeared separately through all solutions of more than 5 factors, a 6 factor solution was considered preferable. In a 7 factor orthoganal solution, (not shown in this paper) the groupings again remained almost unchanged. The extra factor extracted was very similar to one of the other factors, and was, therefore, deemed unnecessary. A 7 factor oblique solution (not shown in this paper) only saw increased similarity between the two factors, making them more redundant and reinforcing the acceptance of a 6 factor solution.

The two final tests supported, in their consideration of variance, the acceptance of a 6 factor solution. Only the first 6 factors had an eigenvalue equal to or greater than 1.0. The acceptance of only a 5 factor solution would mean ignoring an important factor, while the 7 factor solution involved consideration of one factor which had less valuable powers of explanation than each of the original 26 variables. In terms of total variance of the original data explained, the 6 factor solutions revealed 44.3%, the 5 factor solution 40.2% and the 7 factor solution 48%.

Little change in the groupings resulted from the application of an oblique rotation to the six factors, although their order, or relative weight in the solution was changed. Factor III became the first and most powerful factor, with Factors I and II becoming II and III respectively. Horseback riding was dropped from Factor II of the orthogonal solution, but remained with Factor III. Tennis was transferred from Factor II to Factor III. The matrix of correlations among factors in the oblique solution (Table 5) shows fairly low correlations in general, the largest being between the two factors between which the exchange of activities took place, indicating that the exchange had little impact as far as changing the essential

nature of the factors is concerned.

In the oblique solution (Table 4), Hunting is associated to much the same degree with three factors III, IV and VI, rather than only Factor IV of the orthogonal solution. Swimming is also associated with three factors to a similar degree, an indication that there are distinctly different motivations for participation in Swimming, as well as hunting, which are revealed by the descriptions (which follow shortly) of the different factors with which the activity is associated. The Hunting in Group III, for example, may be motivated by the physical activeness of Hunting, while the Hunting in Group IV may be more associated with the desire to establish mastery over nature, and the hunters in Group VI may be attracted by the camping and "outdoorsmanship" elements of Hunting.

An oblique solution is more realistic for the purpose of identifying recreation types as it does not assume that the factors are completely unrelated to one another, and, since there were in this case only a few logical differences from the orthogonal solution, the oblique, 6-factor solution groupings were accepted as the best explanation of the underlying relationships in participation patterns. The next step was to consider the activities in each group to determine their common characteristics (see Table 4).

Group I includes physically active winter activities requiring a minimum of facilities and equipment, and physically active summer activities. All except tennis can be pursued on an individual basis but can also involve groups of individual participants. Very little organization is required and cost is minimal, although tennis and horseback riding can, in some cases, require both organization and money. All activities are enhanced by some degree of skill and can be pursued at a competitive level, excepting possibly snow sledding tobogganing-sleighing. The lowest scoring activities are characterized by their passive nature.

A physically passive dimension emerges in Group II. All activities but swimming and outdoor photography involve travel as an essential part of the pursuit, and, as a result, tend slightly towards a rural setting. All but swimming are directly related to simple appreciation of both natural and man made environments. Only outdoor photography tends to be expensive and requires any degree of skill. These characteristics are reinforced strongly by the lowest loaded activities, which are very active, expensive and skill-oriented.

Group III's activities are highly physically active as emphasized by the weakly associated pursuits: picnicking and pleasure driving, for example. The activities are water based, except for snow skiing, and facility oriented. All except swimming are expensive, require a great deal of skill, and involve personal risk and danger to at least some degree, with the added exception of golfing. All involve individual participation, but usually in a group setting.

Group IV is characterized by a need for freedom or

TABLE 6

FACTOR ANALYSIS GROUPS BASED UPON 78 ACTIVITIES
AND 16 ORTHOGONALLY ROTATED FACTORS

	Factor Loading
Factor I (Group I)	
Snow Sledding-1	.45
Bicycling-1	.40
Snow Skiing-1	.38
Horseback Riding-1	.38
Playing Tennis-1	.38
Power Boating-1	.34
Water Skiing-1	.33
Snowmobiling-1	.32
Ice Skating-1	.30
Climbing-1	.28
Canoeing-1	.28
Golfing-1	.28
Hunting-1	.20
Sailing-2	-.03
Nature Study-2	-.02
Photography-3	-.01
Pleasure Walking-2	-.01
Factor II (Group II)	
Other Park Use-3	.45
Sightseeing-3	.44
Historic Sites Use-2	.40
Nature Study-3	.39
Photography-3	.36
Pleasure Walking-3	.29
Climbing-2	.21
Ice Skating-3	-.08
Snowmobiling-3	-.05

	Factor Loading
Factor III (Group III)	
Snow Sledding-3	.45
Ice Skating-3	.39
Climbing-3	.37
Horseback Riding-3	.29
Bicycling-3	.27
Golfing-3	.12
Pleasure Walking-2	-.09
Pleasure Driving-1	-.09
Water Skiing-2	-.08
Factor IV (Group IV)	
Other Park Use-1	.59
Historic Sites Use-1	.56
Sightseeing-1	.50
Picnics-1	.35
Pleasure Walking-1	.30
Pleasure Driving-1	.30
Pleasure Driving-1	.28
Photography-1	.26
Swimming-1	.20
Nature Study-1	.19
Hunting-3	-.07
Snowmobiling-3	-.05
Factor V (Group V)	
Pleasure Driving-2	.63
Sightseeing-2	.47
Historic Sites Use-3	-.06
Ice Skating-3	-.06
Water Skiing-3	-.05

	Factor Loading
Factor VI (Group VI)	
Power Boating-3	.62
Water Skiing-3	.60
Swimming-3	.37
Canoeing-3	.28
Hunting-3	.17
Sailing-3	.17
Picnics-1	-.07
Pleasure-1	-.05
Photography-1	-.04
Factor VII (Group VII)	
Pleasure Driving-3	.73
Playing Tennis-2	-.09
Snow Skiing-3	-.06
Factor VIII (Group VIII)	
Picnics-3	.71
Tent Camping-3	.31
Trailer Camping-3	.25
Nature Study-2	.11
Pickup Camping-3	.09
Horseback Riding-2	-.07
Snowmobiling-2	-.06
Water Skiing-2	-.06
Golfing-2	-.06
Factor IX (Group IX)	
Sailing-2	.39
Snow Skiing-2	.35
Canoeing-2	.33
Power Boating-2	.32
Snowmobiling-2	.30

	Fac Loa
Factor 1X (Cont'd)	
Water Skiing-2	
Swimming-2	
Climbing-2	
Hunting-2	
Historic Sites Use-3	-
Picnics-1	-
Pleasure Walking-1	-
Factor X (Group X)	
No members	
Factor X1 (Group X	
Ice Skating-2	
Horseback Riding-2	
Bicycling-2	
Playing Tennis-2	
Snow Sledding-2	
Pleasure Walking-2	
Swimming-2	
Golfing-2	
Snowmobiling-3	
Sailing-2	-
Pleasure Driving-1	-
Factor X11 (Group	
Historic Sites Use-2	
Other Park Use-2	

TABLE 6

FACTOR ANALYSIS GROUPS BASED UPON 78 ACTIVITIES AND 16 ORTHOGONALLY ROTATED FACTORS

	Factor Loading
Factor X11 (Group X11)	
Photography-2	.23
Pickup Camping-3	.09
Water Skiing-3	-.06
Canoeing-3	-.05
Horseback Riding	-.05
Factor X111 (Group X111)	
Pickup Camping-2	.24
Tent Camping-2	.22
Swimming-1	.17
Trailer Camping-1	.15
Pickup Camping-3	.10
Water Skiing-2	-.14
Bicycling-3	-.12
Pleasure Walking-3	-.11
Climbing-1	-.09
Ice Skating-2	-.09
Golfing-3	-.09
Factor X1V (Group 1V)	
Playing Tennis-3	.34
Snow Skiing-3	.32
Sailing-1	.25
Golfing-3	.16
Golfing-2	.13
Nature Study-2	-.11
Swimming-2	-.08
Pleasure Driving-3	-.05

	Factor Loading
Factor XV (Group XV)	
Tent Camping-1	.32
Trailer Camping-1	.25
Pickup Camping-1	.25
Snowmobiling-3	.18
Hunting-3	.13
Sailing-1	-.09
Photography-2	-.07
Picnics-1	-.07
Nature Study-2	-.06
Factor XV1 (Group XV1)	
No members	

NOTES: Weakly or negatively associated activities below double lines. Factor loading rank in parentheses for activities listed in more than one group.
Appended numbers 1 to 3 indicate depth of participation categories.

See text explanation of depth categories.

TABLE 7

SOME STABLE GROUPS EMERGING FROM THE ANALYSES BASED UPON DEPTH OF PARTICIPATION

GROUP I

Sledding/Tobagganing/Sleighing-1
Bicycling-1
Snow Skiing-1
Playing Tennis-1
Power Boating-1
Water Skiing-1
Snowmobiling-1
Ice Skating-1
Climbing-1
Canoeing-1
Golfing-1
Hunting-1
Tent Camping-1
Sailing-1
Trailer Camping-1
Camping with a Pickup Camper-1

GROUP II

Visiting Other Kinds of Parks-1
Visiting Historical Sites or Historical Parks-1
Sightseeing-1
Picnics/Cookouts Away From Homes-1
Walking/Hiking for Pleasure-1
Driving for Pleasure-1
Outdoor Photography-1
Swimming-1
Nature Study/Bird Watching-1

GROUP III

Sightseeing
Visiting Other Kinds of Parks-3
Visiting Historical Sites or Historical Parks-3
Nature Study/Bird Watching-3
Waling/Hiking for Pleasure-3
Outdoor Photography-3
Climbing-2

GROUP IV

Power Boating-3
Water Skiing-3
Swimming-3
Canoeing-3
Hunting-3
Sailing-3

GROUP V

Sailing-2
Snow Skiing-2
Canoeing-2
Power Boating-2
Snowmobiling-2
Water Skiing-2
Swimming-2
Climbing-2
Hunting-2

GROUP VI

Snow Sledding/Tobagganing/Sleighing-3
Ice Skating-3
Climbing-3
Snow Skiing-3

GROUP VI (Cont'd)

Horseback Riding-3
Cycling-3
Golfing-3
Playing Tennis-3

GROUP VII

Picnics/Cookouts Away From Home-3
Tent Camping-3
Trailer Camping-3
Nature Study/Bird Watching-2
Camping with a Pickup Camper-3

GROUP VIII

Ice Skating-2
Horseback Riding-2
Bicycling-2
Playing Tennis-2
Walking/Hiking For Pleasure-2
Snow Sledding/Tobogganing/Sleighing-2
Swimming-2
Tent Camping-2
Snowmobiling-3

GROUP IX

Driving for Pleasure-2
Sightseeing-2

GROUP X

Driving for Pleasure-3

GROUP XI

Visiting Other Kinds of Parks-2
Visiting Historical Sites or Historical Parks-2
Outdoor Photography-2

GROUP XII

Camping with a Pickup Camper-2
Tent Camping-2
Trailer Camping-2

NOTES: Appended numbers 1 to 3 indicate depth of participation categories.

See text for explanation of depth categories and formation of groups.

mobility in the outdoors combined to some extent with a certain element or feeling of man conquering, mastering or rising above nature. This is rein-forced by the presence of activities such as sailing, climbing and park visitation that involve harmony with nature as negatively associated activities. The group activities are physically active, expensive and require skill. All involve an element of speed and/or danger, and take place in a rural setting.

Appreciation of and harmony with nature are common to Group V. Hunting and snowmobiling are among the lowest loaded activities on this factor. There is little requirement for facilities or equipment other than a camera. The activities can be physically active or passive and generally to involve an element of both. They also tend to be individual pursuits requiring some degree of skill or knowledge and are heavily concentrated in the rural environment.

Group VI involves travel and outdoorsmanship. All pursuits are active to some degree, and require some knowledge and skill. Facilities and equipment are prerequisites. All pursuits occur in a rural setting and tend to be group activities, although individuals can participate alone. The presence of bird watching-nature study, hiking-walking for pleasure, and sailing as the least related activities may indicate that the majority of campers may be motivated by other factors than the appreciation of nature, as one might have expected. Possibly, the need for cheap accommodation on holidays, and mobility are most important in the growth of camping.

For the purpose of monitoring the effects of depth or participation on the groupings, 4-factor analyses in total were applied to the 78-activity set yielding orthogonally rotated solutions of 10, 16 and 18 factors, and an obliquely rotated solution with 14 factors. Only the 16-factor solution is presented in this paper. Both the 14- and 16-factor solutions had a tenth factor which measured a dimension not easily described by the activities. No activities in the 16-factor case and only one in the 14-factor case loaded most highly on this factor. The final, sixteenth factor also measured a dimension to which none of the activities was most directly related, so the 16-factor solution resulted in only 14 actual groupings. The 16-factor solution was also a good representation of all 4 solutions. Since we ignore the Factor XVI of the 16-factor solution, there is an explanation of somewhat less than 36.5% of the total variation. The following is a discussion of the 14 groups produced by the 16-factor solution (refer to Table 6).

Group I is characterized by general light participation in a large number of activities all of which are very active in the physical sense and require some skill. All of the solutions of the 78-activity set produced a somewhat similar group.

Heavy participation in the passive appreciation activities comprises Group II. All activities are generally

cheap with the possible exception of photography, and none involve risk or danger. The negatively associated activities, heavy participation in ice skating and snowmobiling, are both active and can involve risk.

Group III also involves heavy participation, but in active, non-water-based activities requiring a fair amount of skill. Light participation in pleasure driving and moderate participation in active water-based activities score negatively.

Another more general light participation group emerges as Group IV, this time of passive appreciation activities. Some knowledge, but generally little skill, is required by these pursuits which occur in a rural environment and include travel as an integral part of the activity. Group V has only two activities but is an indication of a very strong dimension of moderate, highly travel related passiveness. This nature is emphasized by the negative loading or heavy participation in the specific purpose activity of visiting historical sites, and heavy participation in very active and sometimes risky water skiing and ice skating.

Heavy participation in active, water-based activities requiring skill is measured in Group VI. These activities, sometimes involving the elements of speed and danger, are countered by the very passive nature of the negatively related pastimes.

Group VII's only member, extensive pleasure driving, is another indication of the powerful automobile-related passive factor in Canadian recreation. Those who do a great deal of pleasure driving tend not to participate heavily in active pursuits such as tennis and snow skiing, which score negatively on this factor.

Heavy participation in a movement into the outdoors factor is indicated by Group VIII. Travel is an integral part of these activities, which generally require some equipment and can be active, but are not usually physically demanding. The negatively associated activities are active and sometimes involve speed and personal risk.

Group IX sees a recurrence of the active water-related activities, this time at a moderate level of participation. Snow skiing still is a member of this group because of its active and speed factors, and hunting and climbing are related, probably by their active nature.

Factor X does not produce a group as there are no highly related activities for it. Group XI is defined by the moderate level of participation in the active, non-water-based activities. The group is quite similar to those formed by the other levels of participation in the same type of activities: Groups I and III.

Moderate participation in passive-appreciation pursuits forms Group XII. Sightseeing and pleasure driving, which are usually in this type, have combined to produce the travel-based passive Group V.

Group XIII sees emergence again of the camping-outdoorsman factor, this time at the moderate participation

level. It is interesting that camping with a pick-up camper is a member of this group at both moderate and heavy levels of participation. This occurence indicates that there is little motivational difference behind moderate and heavy pick-up camping.

Active, skill-requiring activities comprise group XIV. All are at the moderate or heavy participation level except sailing, which is also the only water-based activity. Perhaps the availability of accessible water facilities limits participation in sailing, which remains attractive to this recreation type. The presence of golfing at both moderate and heavy levels may indicate that, generally, there is a common set of attractions for golfers who participate more than five times per year.

Group XV is the light participation camping-outdoorsman group, but is joined by two activities that are physically active and at the heavy level of participation. This combination may result from a relationship between occasional camping and heavy participation in snowmobiling and hunting, as camping may sometimes be a part of the latter activities. Factor XVI, like Factor X, does not produce a viable group.

Several interesting characteristics of Canadian participation patterns have emerged from the analyses based on depth of participation. The most striking, perhaps, is that Canadians tend to confine their participation in all their activities to the same level; those who participate heavily in certain activities tend to participate heavily in all their activities. This trend is revealed by the fact that, with only a few exceptions, groups were formed by the same level of participation in the member activities.

Depth of participation in activities would seem to depend more on the individual's general desire to participate than on the nature of the activities themselves. While there certainly must be motivational differences between marginal and heavy participation in an activity, these differences seem to apply to all activities within the individual's range of participation. That is, those motivations which prompt a person to participate extensively in one activity also result in his extensive participation in his whole range of activities. Thus activity groupings remain very similar at all levels of participation.

Only a few activities were placed at one level in a group comprised of a different level of participation. This placement resulted from various causes, including the dual nature of some activities such as moderate climbing whose characteristics are illustrated by its membership in both the active Group IX and the passive appreciation Group II. A basic difference between one activity and a group of otherwise highly related pursuits may be a second cause of the grouping of activities at different participation levels. The inclusion of only light participation in sailing in Group XIV, possibly due to its water requirement, has been mentioned as an example. A third cause may be the occasional participation in some activities in the course of

pursuing others, as has been mentioned for snowmobiling, hunting, and camping in Group XV. Finally, a fourth cause may be the arbitrary delineation of the different levels of participation. Golfing and camping with a pick-up camper have been mentioned as activities to which the division point of ten occasions of participation between moderate and heavy participants may not be valid.

While Canadians seem to be either light, moderate, or heavy participants in their whole range of activities rather than light participants in some of their group of pursuits and heavy participants in other, they also seem to be very dependent on passive recreation relying on the use of the automobile. Of the 14 viable groups resulting from the 16 factor analysis, several possessed an element of travel, and two (Groups V and VII) were formed only by moderate pleasure driving and sightseeing, and heavy pleasure driving, respectively.

In all of the analyses of the 78-activity set, the first factor, and therefore the strongest dimension of Canadian outdoor recreation participation, was light participation in a broad range of activities. The members of this group varied slightly from analysis to analysis, but generally they were active outdoor recreation pursuits.

In an attempt to determine the stability of the groupings based on depth of activity, the groupings produced by all four solutions involving 78 activities were compared. Twelve groups were formed by members that were associated with each other in at least three of the four analyses. They are listed in Table 7.

DETERMINING AGGREGATES OF PEOPLE: CLUSTER ANALYSIS RESULTS

One of the easiest ways to understand how a particular cluster analysis proceeded and how to interpret the results is to look at Figure 1 and to see how the sequence of events depicted relates to the actual cluster description presented in Table 8. The reader who is knowledgeable about cluster analysis will see from the "tree" in Figure 1 that the clusters were formed by what is described in the Appendix as a monothetic divisive algorithm. This was done because the use of this algorithm was relatively cheap and in that respect appropriate for a preliminary study. However, as indicated later, there is good reason to believe that an alternative algorithm should be used in subsequent studies if only to avoid the biases that arise when terminal clusters become a function of the sequence of division that is carried out.

From Figure 1, one sees that the initial split of the universe of 1100 people (used because of available core storage in the computer) was on swimming. By breaking the population into two groups on the basis of whether they did or did not participate in swimming, it was possible to get two more homogeneous groups of people: more homogeneous in terms of the activities in which they did or did not

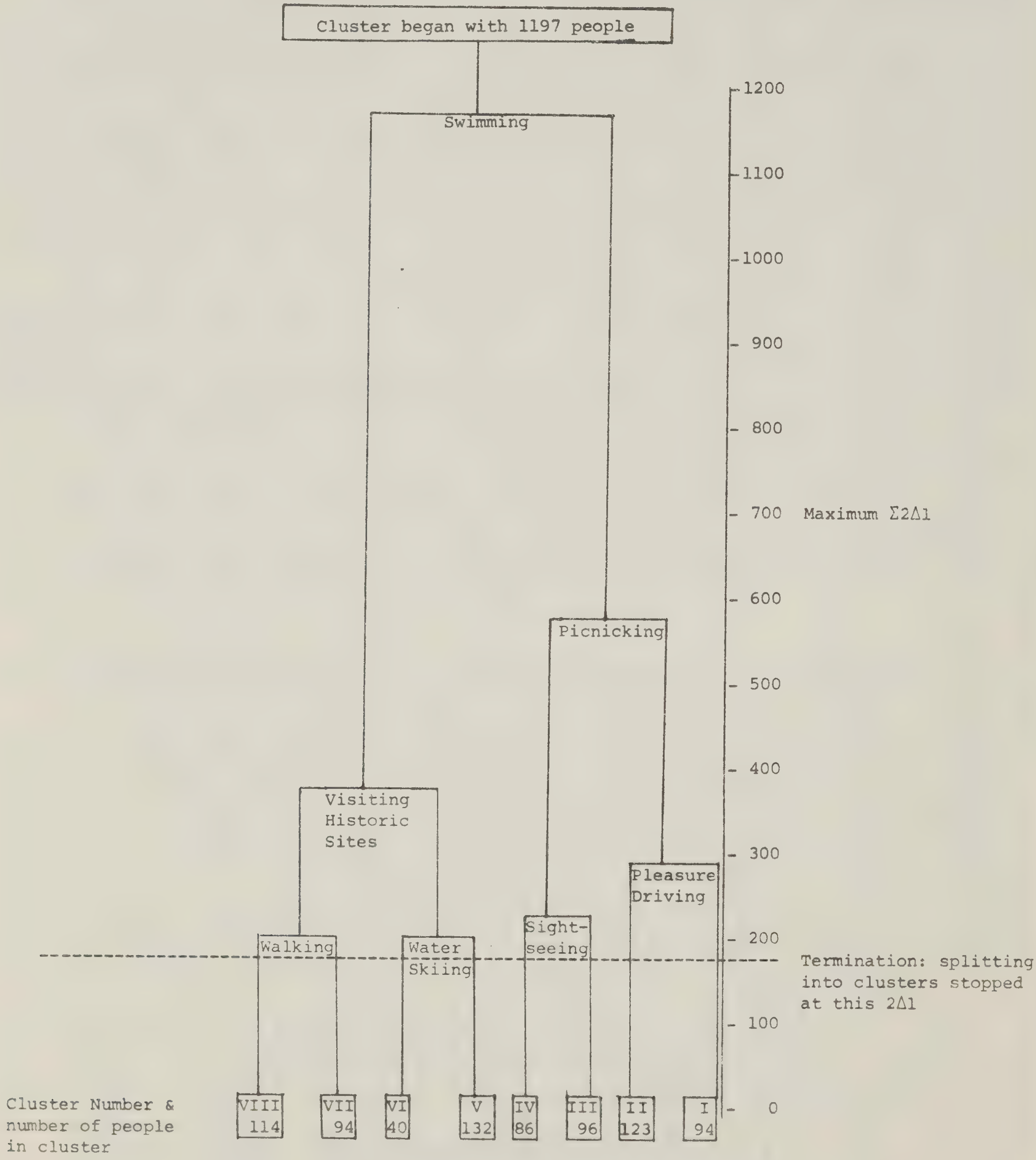
TABLE 8

PATTERN OF CLUSTER FORMATION THAT OCCURED IN DETERMINING CLUSTERS USING CORD 1969 STUDY NATIONAL DATA

	% Occurence								% in the cluster that participated compared to the % in the population							
	CLUSTER NUMBER								CLUSTER NUMBER							
	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8
1. Swimming	0	0	0	0	100	100	100	100	0	0	0	0	2.46	2.46	2.46	2.46
2. Tent Camping	1	3	15	12	14	26	17	32	.10	.24	1.22	.93	1.07	1.70	1.33	2.52
3. Trailer Camping	1	2	10	13	3	10	5	10	.11	.26	1.78	2.21	.59	3.39	.80	1.80
4. Pick Up Camping	0	0	1	5	3	7	2	3	0	0	.45	2.55	1.77	3.39	.80	1.35
5. Hunting	4	7	14	11	14	26	11	15	.39	.62	1.28	1.01	1.27	2.43	1.00	1.37
6. Power Boating	3	5	10	13	24	71	41	36	.17	.28	.56	.70	1.29	3.89	2.24	1.97
7. Canoeing	0	2	4	2	10	36	9	21	0	.30	.58	.27	1.37	4.80	1.23	2.78
8. Sailing	1	0	2	0	3	19	6	11	.17	0	.49	0	.97	5.57	1.75	3.20
9. Water Skiing	0	2	0	2	0	100	14	15	0	.22	0	.28	0	14.39	1.97	2.22
0. Bird Watching	3	9	14	14	9	16	6	21	.28	.84	1.29	1.29	.90	1.54	.58	1.95
1. Photographing	7	19	25	25	24	16	33	53	.27	.79	1.02	1.05	.98	.67	1.38	2.19
2. Visiting Historic Sites	9	26	27	66	0	0	100	100	.25	.70	.73	1.76	0	0	2.67	2.67
3. Visiting Other Parks	11.1	28	27	71	38	52	71	76	.26	.68	.66	1.72	.91	1.25	1.73	1.84
4. Driving for Pleasure	0	100	71	90	71	71	73	82	0	1.53	1.09	1.38	1.09	1.09	1.11	1.25
5. Sightseeing	7	45	0	100	36	58	62	75	.17	1.06	0	2.37	.86	1.38	1.47	1.78
6. Climbing	1	2	0	6	3	13	0	21	.13	.31	0	1.21	.70	2.68	0	4.44
7. Snow Skiing	0	2	3	4	7	55	14	18	0	.20	.35	.53	.91	7.42	1.85	2.43
8. Snowmobiling	4	6	12	11	18	45	26	15	.32	.45	.92	.83	1.40	3.48	1.99	1.19
9. Tobogganing	2	2	8	13	16	48	18	33	.18	.12	.58	.96	1.22	3.66	1.38	2.52
0. Picnicking	0	0	100	100	62	58	70	87	0	0	1.87	1.87	1.15	1.09	1.30	1.63
1. Walking	15	26	30	42	46	48	0	100	.39	.70	.76	1.10	1.22	1.28	0	2.64
2. Golfing	3	4	4	11	12	45	21	26	.26	.33	.38	.95	1.01	3.99	1.88	2.27
3. Ice Skating	2	5	13	13	30	55	38	38	.10	.27	.68	.67	1.60	2.90	2.00	1.99
4. Horseback Riding	3	1	5	6	8	19	8	19	.42	.11	.72	.83	1.15	2.75	1.08	2.67
5. Bicycling	4	5	3	10	16	19	15	27	.37	.47	.31	.88	1.46	1.75	1.37	2.39
6. Tennis	1	2	5	3	8	26	11	22	.08	.30	.69	.40	1.09	3.49	1.44	3.01

FIGURE I

NATIONAL ACTIVITY PACKAGES BASED ON 1969 CORD STUDY NATIONAL SURVEY DATA



participate. A group of people who did not swim (not swimming by a "No" on the right-hand branch in the figure) was further divided on the basis of whether they did or did not go picnicking. As shown by the "maximum 2øI" axis, the splitting on picnicking further contributed to defining homogeneous groups. Other splits were made on the basis of visiting historic sites, driving for pleasure, sightseeing, walking and water-skiing, and can be seen from the figure.

Dividing people into groups in the way suggested means that some of the aggregates, which have been called terminal clusters, will have people who do not participate in certain activities and some of them will have people who do participate in certain activities. This is the way that the clusters were defined in this analysis. This is obvious from Table 8 when one looks at the percentage occurance figures and sees that, for example, in cluster 2, 100% of the people drove for pleasure. Driving for pleasure is a defining characteristic of this cluster along with non-participation in picnicking and non-participation in swimming. So, also one sees that there was no participation by people in cluster 2 in the activities swimming and picnicking. However, one only really learns something new when one sees that for cluster 2 there was also no participation in the activity sailing or in the activity pick-up camping. These latter activities do not have zero participation by definition. Having zero participation conveys real information about other activities that people in this aggregate do or do not participate in. For further illustration, cluster 1 of Figure 1 indicates that not swimming, not picnicking and not driving for pleasure are defining characteristics. In the percentage occurance figures in Table 8, one sees that zero participation in these activities occurs. Zero participation also occurs in pick-up camping, water skiing, snow skiing: very little participation, even compared to people in cluster 2, occurs in many other activities. So a picture begins to emerge of the people in cluster 1 being far less active than people in cluster 2.

The results presented in Table 8 are interesting in a number of respects that have not been covered in the descriptive discussion above. They certainly make clear that there are groups of population that have different activity packages, so a planner should not think of the population as a homogeneous body of people who have a certain probability of participating in each of a number of activities independently of other activities they participate in. The importance of this in making projections is commented on earlier in this paper (also in TN 13, 29, 32).

Still, the analysis leaves something to be desired. The algorithm used does not allow some people who may participate in a number of the activities that are included in one of the more active clusters to be in that cluster unless he does or does not participate in the two or so critical activities that define that cluster. This is because a monothetic divisive type of cluster algorithm was

employed to define clusters. But the influence of supply on what people participate in may automatically eliminate people from a cluster because, where they live, it is not convenient to participate in a certain key activity which defines a cluster.

One who has taken some biology will recall that the classification problem is one of defining critical characteristics. Many characteristics are not critical in determining whether a certain plant should be grouped with other plants. At first examination it may even appear curious that certain plants or animals are grouped together. This kind of consideration carries over to studying the groupings of recreation activities if one wants activity clusters for aggregates of people if clusters are to be truly behaviourally meaningful. It is the belief of the authors that if one wants to consider substitutability and recognize the fact that it may be operative for different individuals who would be in the same cluster, it is critical to carry out cluster analyses with a "natural class-seeking algorithm" (see Appendix).

In terms of guidelines for further research one may note that it is possible to achieve more natural clusterings by incorporating supply information into a cluster analysis. The way that this can be done is to use existing supply information on two different areas to form a weight that is used in determining how significant the difference between participation in a given activity is between the areas in which live the two people being considered. If two persons who live in different areas are being compared, then instead of simply taking the difference between some numbers that reflect whether a person is a non-participant, or a regular or irregular participant and squaring these and adding them up over all activities, one may take this squared value and weigh the difference by reducing it if there is a difference in supply that reduces the difference in scores (depending on whether the difference in supply in the two areas is large, medium or small, defined according to some arbitrary scale that is set up). In particular one might use the kind of potential map generated for camping in TN 5, but for each activity have a similar kind of map so that the potentials in every geographic area would be known. On the basis of such a map differences would be taken as reflecting true differences if the potential were within 25% of each other and in other cases a correction would be introduced to say that the differences between the people and the activities in which they participate, and to reflect supply and thereby the participation level of one person, would be shifted towards the potential of the other person by varying degrees depending on how much the potential for the activities actually did deviate between the two areas.

This proposal does not get into the more tricky matter of substitutability or what some people refer to as substitute supply. Until some work is done in the more straightforward way just suggested, and until actual behavioural information becomes available on what

substitutions people do make and why, it is not really plausible to make a suggestion about how to take into account substitution in defining clusters. At this point it is simply important to note that substitution must be considered when one is aiming at defining natural classes as opposed to defining classes which, when corrected for availability of supply, may have a strong bias toward meeting certain mathematical conditions rather than telling one truly about behavioural influences that are operating on people.

In this discussion the matter of examining socio-economic characteristics of people who are in various aggregates that are determined using cluster analysis programs have almost been totally ignored. In the introductory discussion, particularly that based on the work by Burton, the value of knowing socio-economic characteristics was stressed with respect to the matter of making projections. This theme is taken up in CORD Study Technical Notes 13 and 32, in particular. Here, it is only necessary to note that in work already published by Romsa (Reference 49) results have been presented on the characteristics of people in relation to the aggregates to which they belong. It is not a difficult matter when a person has been classified into a given cluster to carry out analyses of the individual clusters to see what characteristics people have, but it is not a simple matter to characterize a cluster by the characteristics of the people who are in it because there may be a wide range of ages of people and there may be wide deviations in the socio-economic characteristics. Giving a "typical profile" based on average education, average income, etc. for a cluster is not a very adequate way of indicating what socio-economic characteristics are really important with respect to a cluster. In fact, there may be somewhat the same problem associated with characterizing clusters as there is in saying what activities really constitute the important activities in defining an activity package. The income variable may not be important for one activity even though people in the particular cluster involved have an above average income: it may in the case of this cluster be the rural urban variable that is important and the income difference may only express the highly urban concentration of people in a particular cluster. Regardless, it should be clear from depreciating examples that the issue of characterizing clusters is seen as important and is yet another area that must receive attention if practical use or even academic uses may be made of the procedures for deriving aggregates of individuals from information on their participation in various activities.

CONCLUSION

From the results presented in this article one can see that the two analysis strategies used produced results that are quite different in terms of what they mean, but which may be confused. Clearly when one speaks about activity packages, unless there is general acceptance that this is not a collection of inter-correlated activities determined by R-mode factor analysis, there is the possibility that one will misunderstand what is meant. Similarly when a list of activities is presented and it is said that these define a "recreation type", one may become confused and not realize that this is the collection of activities with which people have been associated in the way described by Burton. Thus one can see that from a practical perspective it is very important to indicate whether lists of activities define groups in the sense of Burton or whether the lists relate to the activity package of a group of individuals in the spirit of the other methodology.

Obviously, the two different sets of results do not have the same implication for planning. Knowing that a certain proportion of the universe of individuals is characterized by participating in a certain group of activities means that a planner can know what proportion of the universe being studied is served by a certain activity. By looking at cluster after cluster he is able to see how important a certain activity is in the different activity packages of the different aggregaters of people into which a universe has been divided. He can even put this importance in perspective by presenting figures on the size of the various aggregates. He may say that for 15% of the population a certain activity is one of the two activities usually participated in (these people have only 2 activities) while for 30% of the population this activity was only 9% of their activities (meaning these people had about 12 activities in their activity packages). Such a statement could be made for several groups with activity packages ranging in size from 8 or 9 activities to 15 or 16 activities.

The reader may wish to attempt to formulate for himself an example of where the Burton cluster of activities information would be useful. As indicated in the beginning of this paper, there are other studies that comment on the uses of cluster analysis and on the Burton factor analysis methodology (TN 32, 37, Reference 49.) Since these matters need not be pursued here the example just introduced is not elaborated on. However, it is in the context of the example and the kind of planning concerns just raised that the future of the kind of research presented here lies.

This article has only shown the feasibility of certain lines of analysis without pursuing in depth even what the implications of carrying out these analyses are. An obvious next step is the preparation of papers where actual management applications of one or other of the techniques are made. Another area for further research is that of

theory development in relation to which of the models should be used and in what circumstances. This involves clarifying the behavioural considerations relevant to the use of factor analysis in cluster analysis as has already been begun (see TN 32, 37).

APPENDIX

DESCRIPTION OF SOME PROGRAMMES USED IN CLUSTER ANALYSES

C. Peebles

Cluster analysis is a term which covers a multitude of strategies and algorithms designed either to group similar individuals as a function of their attributes or, more rarely, to group a number of related variables scored over a series of individuals. Excluding parametric multivariate techniques such as factor analysis and joint metric space and partial order scalogram analysis, Wishart (Reference 67) has classified cluster-analytic strategies into two basic groups: (1) "natural class" seeking algorithms and (2) optimum solution methods. The first of these major divisions has received attention from only a few workers - (e.g. Wishart (Reference 65, 66, 67) and Jardine and Gibson (Reference 33). It is the second of Wishart's two categories that has seen the bulk of activity in cluster analysis. This is largely because it offers solutions that are optional in terms defined by the investigator rather than in "natural" terms that are defined by complex methodological and epistimological dimensions of the problem and data. (See Reference 33) for a discussion of "natural" class problems in numerical classification of biological organisms. In the assignment of individuals to species, the requirements of both proper taxonomic assignment and phylogenitic grouping must be met.)
Within the second major group of clustering strategies a further division can be made. As Wishart says:

> Probably the most common technique is the hierarchic fusion algorithm which has the advantage (although very expensive with large populations) in presentation of the resulting "dendrogram". The construction of "keys" was a requirement of botanical applications that gave rise to the early monothetic divisive techniques, enabling observers to identify plant communities by the presence and absence of certain key species. The third recurring technique ... improves a given classification by itterative relocation of cluster members so as to optomise

some objective measure of overall homogenity in terms of the similarity between individuals and clusters. Also known as the "X-mean", "transition" and "euclidian cluster" methods it is economical in computer processor time and appears to find global optimum solutions for most small populations.

In general, most hierarchic-fusion algorithms have in the past been called polythetic-agglomerative to contrast them with the monothetic-divisive strategies. Polythetic-agglomerative clustering groups individuals on the basis of a measure of similarity or dissimilarity generated from the measures of their attributes. Based on these measures of similarity or dissimilarity between all members, clusters of related individuals are grouped by a "rule" in the algorithm. An almost inexaustable array of measures of relationship between individuals measured over both binary and continuous attribute states have been used. The methods - or rules - for grouping individuals have been equally large: single, average, and complete linkage, errorsum, information gain, and cliques, clumps, and stars to name a few. In each case the measure is either minimized or maximized as a criterion for inclusion of an individual in a group or for the fusion of two groups.

The monothetic-divisive algorithms work in exactly the opposite manner. Instead of being built into more and more inclusive groups a population of individuals is partitioned into more and more homogeneous sub-sets. Williams and Lambert (Reference 62) the originators of monothetic-divisive analysis in plant ecology, defined the problem as the subdivision of

> ... a population so that all associations disappear; but there will in general be a large number of alternative subdivisions fulfilling this requirement. We therefore propose the concept of efficient subdivision, by which we intend subdivision of that species which, in the two subclasses resulting, produces the smallest total number of residual significant associations.

They propose X^2 as the measure and the variable with the highest @E X^2 as the divisor. That is, if the population is divided into individuals with and individuals without the attribute which shows the highest @E X^2 the largest number of associations will be eliminated. The resulting sets will be the most homogenous of any possible pair drawn from the initial population.
The use of @E X^2, however, has several undesirable properties.

> ... in the qualitative case we have become increasingly dissatisfied with the X^2 model, which has proved excessively sensitive to skewness of

the underlying distribution; as a result, the simultaneous possession by an individual of two uncommon attributes assumes a quite disproportionate importance. (Reference 37)

Lance and Williams, Orlocki (Reference 46), McNaughton-Smith (Reference 42) and others have proposed the Information Statistic 2øI be used in place of @E X^2. The Information Statistic asymptotically approaches the X^2 distribution when the population over which it is computed is large. The Information Statistic 1 can be symbolized

øI(AB) = I(1;2)(AB) - I(1;2)(A) - (1;2)(B)

WHERE the I's represent CHI(1) the mutual information between two frequency distributions CHI, and CHI(2) representing the row and column classifications in table A or B in their union A + B (Reference 42).

For a 2 x 2 table where both variables are binary, 2øI becomes 2(B+C) log(2) where B and C are the upper right and lower left cells of the table. The population is divided on that attribute for which the @E 2øI is largest. Such a division results in the greatest amount of information fall in the two resultant populations.

Cluster analysis, whether agglomerative or divisive, monothetic or polythetic, is a data reduction device. The sampling distributions and statistical properties of various techniques have not been worked out. Thus any statistical inference based solely on the results of a cluster analysis is suspect at best. If, however, the results of a cluster analysis fulfill some theoretical expectation or are subjected to further, external statistical testing then cluster analysis can be a very powerful technique. The programs used in this study were part of Wishart's CLUSTAN IA Suite and were run on the University of Windsor's IBM 360-050.

OBTAINING EFFICIENT ESTIMATES OF PARK USE AND TESTING FOR THE STRUCTURAL ADEQUACY OF MODELS

J. Beaman, J.L. Knetsch, H.K. Cheung

ABSTRACT

This paper provides an examination of the problem of heteroscedasticity as it relates to estimating park use, although the results can also be applied to a wide variety of flow problems involving traffic, people or commodities. The major issue is that estimates of flows obtained using ordinary least squares, OLS, often yield statistically significant results while still giving rise to large differences between observed and predicted flows.

The paper presents results which show that for the flow estimation problem of concern, more accurate use estimates may be obtained by using generalized least squares, GLS, rather than using OLS. Weights to use in a GLS regression are derived. These are presented in a covariance matrix which is developed taking in to account the variance to be expected in origin-destination flows.

It is shown that deriving the correct weights, estimates of variances, to use in a regression analysis results in an "absolute" test for the structural appropriateness of the regression model. Tests related to the "absolute" adequacy test are introduced and their use to identify specific structural problems with a model is illustrated.

INTRODUCTION

Increasingly, more formal methods of estimating attendance at proposed parks and recreation areas are being used in the planning and justification of such areas. Ordinary least squares regression (OLS) models are characteristically developed to estimate the relationship between (1) measures of the use of parks and recreation areas, usually specified as the volume of origin-destination flows for a number of existing sites, and (2) various independent variables influencing a park's use. These latter variables are usually chosen to reflect the characteristics of the sites under consideration and to be measures of the size and proximity of populations from which visitors come. (See References 1, 2, 9 and 10.)

While the "relations" established by these kinds of

regression are statistically significant, there is typically an undesirable lack of precision in the prediction of actual origin-destination visitor flows (attendance figures). Estimates often differ from observed values on which they are based by several hundred percent" thus there is a problem with the accuracy of estimates. (See References 5, 6.)

The difficulty can be illustrated by examining the origins of visitors to a provincial park in Saskatchewan (Rowan's Ravine) and employing a simple model to explain the variation in flows as a function of the distance from the visitors, origins to the park (see Table 1) and the sizes of the populations at the origins. The total observed 1969 attendance at this park was 9,828 parties, coming from fifteen different origin areas. However, of the total, 5,868 parties (or about sixty percent) came from a single origin area located fairly close to the park and containing Regina, the largest population centre in the region.

Ordinary least squares regression was used to estimate the parameters in Equation 1. The relationship between various flows from the different origins to Rowan's Ravine was obtained:

(1) $\log ((V(o,d) + 1)/ P(o)) = 2.811 - 0.0241\ D(o,d)$

WHERE $V(o,d)$ is the number of visiting parties coming from an origin, o, to a park,d' $P(o)$ is the population in thousands of o; and $D(o,d)$ is the distance from o to the destination, d,in road miles. The constant 1.0 was added to visit numbers to avoid the problem created by taking the logarithm of zero. Logarithms used were 'base 10'.

Equation 1 proved a reasonable explanation of the variation in the dependent variable. The R^2 for the regression is 0.77. The regression coefficients are highly significant according to the usual F-test. Also, the standard error of the regression coefficient of $D(o,d)$ is only 0.00783. Nevertheless, the explanation of the use of the park is not particularly good, as can be seen from Table 1. Even though the fitting was done using the data shown, the estimate of a total of 5,887 visiting parties from all origins is nearly 4,000 below the actual total visitor flow.

In using OLS regression to estimate relationship between visits and distance, each observation point was treated as if it were as important as any other. In the example, the use of OLS regression treats the observation for origin unit 4 (which contributed 60 percent of the observed total use) as the equal of the observation for origin unit 13 (which contributed approximately 0.3 percent of the total use) or the same as observation 16 which involved no visits and therefore contributed nothing to total use.

While errors in prediction are partly due to omission of causal factors and 'measurement errors' (see Reference 9), a further and major cause of poor predictions using the model is clearly the heteroscedasticity among the

TABLE 1

STATISTICS PERTAINING TO OBSERVED AND ESTIMATED DAY VISITS TO ROWAN'S RAVINE PROVINCIAL PARK, SASKATCHEWAN

Observation Unit	Distance to Park in Miles	Population	Observed Visits, Vehicles	Estimated Visits unweighted regression
1	133	32,489	36	11
2	126	51,923	0	29
3	104	17,813	63	34
4	61	132,432	5,868	2,890
5	34	11,594	720	1,133
6	14	1,632	1,980	483
7	21	3,871	378	778
8	67	2,829	36	43
9	110	36,889	99	51
10	107	3,271	0	4
11	109	6,181	18	8
12	40	4,237	414	296
13	139	21,104	27	5
14	84	16,284	63	98
15	154	117,405	126	21
16	117	4,456	0	3
17	129	2,729	0	0
			9,828	5,887

Observation Unit	Estimated Visits weighted regression	Per cent error unweighted regression	Per cent error weighted regression
1	22	227	64
2	55	-100	-100
3	66	85	-5
4	5,731	103	2
5	2,315	-36	-69
6	1,011	310	96
7	1,614	-51	-77
8	86	-16	-58
9	98	94	1
10	9	-100	-100
11	16	125	13
12	601	40	-31
13	10	440	170
14	190	-36	-67
15	38	500	232
16	7	-100	-100
17	1	-100	-100
	11,870		

* $$\% \text{ error} = \frac{\text{Observed Visits} - \text{Estimated Visits}}{\text{Estimated Visits}} * 100$$

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observations, and this is not properly dealt with when estimating the parameters. The preceding statement is made without applying a test for heteroscedasticity (see References 7, 8) because, in the following, the nature of the variance in observations is derived.

A FIRST STEP TOWARD 'PROPER' ESTIMATION: DERIVATION OF A COVARIANCE MATRIX FOR THE OBSERVED VISITOR FLOWS

When the parameters of a model are estimated using generalized least squares (GLS), it is necessary to know the covariance matrix of the observations. Subsequently, a covariance matrix for observed visitor flow, Iv, is derived which is critical in obtaining the covariance matrix of transformed observation,It, that is eventually used in a regression analysis. To facilitate the discussion involed in deriving Iv the following notations and definitions are used:

v(o,d,t,g) observed number of vehicles, with parties in collectivity g, going from origin o to destination d on day t;

WHERE the collectivity g is a set of parties which tend to have similar behaviour in terms of their probability of participating in a given package of recreation activities at destination d on a day t with its given weather, park crowding and traffic, conditions, etc.

{v}(o,d,t,g) the predicted value of v(o,d,t,g)' an estimate,

p(o,d,t,g) the probability that a party in collectivity g would go to d from o on day t,

V(o,d,t,g) the random variable that generates the observed values v(o,d,t,g),

E(V(o,d,t,g)) expected value of V(o,d,t,g)

VAR(V(o,t,d,g)) variance of V(o,d,t,g).

Additionally, when some subscripts are removed from v(o,d,t,g), the resulting expression implies ,a sum over the

given subscript(s)'. The number of parties going from origin o to a destination d on day t is v(o,d,t) = @E g v(o,d,t,g); the number over all days is v(o,d) = @E t @E g v(o,d,t,g); and the total attendance at the park is v(d) @E o @E t @E g v(o,d,t,g) = @E o v(o,d).

The most usual assumption in regression analysis (the OLS or homoscedasticity assumption) is that v is a diagonal matrix of the form:

$$Sv = @E^2 \begin{vmatrix} 1 & & & 0 \\ & \cdot & & \\ & & \cdot & \\ & & & \cdot \\ 0 & & & 1 \end{vmatrix}$$

WHFRE @E^2 is the variance that applies to all observations.

But, now consider that visitor flows from o to d on day t for group g depend on N(o,g), the number of people in g available to participate, and p(o,d,t,g), their probability of participating. The very nature of the definition of V(o,d,t,g) in terms of N(o,g) and p(o,d,t,g) implies that V(o,d,t,g) is a binomial random variable with mean and variance as follows:

(2) E(V(o,d,t,g)) = N(o,g)p(o,d,t,g)

(3) VAR(v(o,d,t,g)) = N(o,g)p(o,d,t,g)(1-p(o,t,g,d))

and, if p(o,d,t,g) is small, Equation 4 holds so that Equations 5 and 6 follow.

(4) VAR(V(o,d,t,g) approx = N(o,g)p(o,d,t,g) = E(V(o,d,t,g))

(5) E(V(o,d,t) approx = @E VAR(V(o,d,t,g))

WHERE the summation is over g.

(6) VAR(V(o,d,t) approx = @E VAR(V(o,d,t,g))
= @E E(V(o,d,t,g))
= E(V(o,d,t))

One should note that v(o,d,t) can be observed and it is an estimate of E(V(o,d,t)); an observation is an estimate of its expected value (if the expected value exists). So, from Equation 5 one can see that it is possible to obtain estimates of the variance of V(o,d,t).

Similarly, for total use from an origin to destination, one obtains:

(7) VAR (V(o,d)) approx = @E VAR(V(o,d,t)
= @E E(V(o,d,t))
= E(V(o,d))

WHERE the summation is over g.

Thus the variances in V(o,d,t) and V(o,d) are approximately proportional to their respective expected values, meaning that either observations or predicted values can be used as estimates of the variance V(o,d) (see Equation 4). The merits of using observations to define weights to obtain estimates that can then be employed as variance estimates in a second cycle of estimation is not discussed.

Now it will be the exception, rather than the rule, that a change in vehicle flow to one site will be correlated with change in visitor flows to other sites. This is because a trip by a single visiting party of a given type on a given day from a given origin to one site or another is not expected to influence the decision of other parties in other vehicles. Obviously, parties may make decisions based on what they think other parties will do, but this is not the issue.

Assuming that the fluctuations in daily flows to one origin-destination pair for one type of user are not correlated with similar flows to another origin-destination pair, it follows that the estimated covariance matrices of v(o,d) can be written as follows (with the matrix for v(o,d,t) or other observations being written in a similar way):

$$(8) \quad Sv(o,d) = \begin{vmatrix} \cdot & & & 0 \\ & \cdot & & \\ & E(V(o,d)) & & \\ & & \cdot & \\ 0 & & & \cdot \end{vmatrix}$$

This matrix would be the appropriate covariance matrix of observations if non-linear regression were being used with the v(o,d) as the dependent variable. (See Reference 8.)

OBTAINING MODEL PARAMETERS USING LINEAR REGRESSION

To regard the estimates of the parameters as efficient, certain distributional properties of the error term e(o,d) must be assumed. The form of Equation 1 suggests that the 'fluctuations, in the random variable V(o,d) define the variance of the error term e(o,d). It is complicated to give an exact relationship that shows how the fluctuations in V(o,d) define fluctuations in e(o,d). However, a Taylor series expansion of log (V(o,d)+1)/P(o) around E(V(o,d,)) results in Equation 1 taking the form shown in Equation 9 which, after 'simplification', results in Equation 10.

$$(9)\ \log f + (d[f]/d[v](o,d))\ \overline{\text{DELTA } V(o,d)} \text{ approx } = a + bD(o,d) + e(o,d)$$

WHERE

$F = \ln ((V(o,d)+1)/P(o))$ and

the derivative is evaluated at $E(V(o,d))$

$$(10)\ \ln f + \frac{\overline{\text{DELTA } V(o,d)}}{E(V(o,d)) + 1} \text{ approx } = a + bD(o,d)+e(o,d)$$

Because the random fluctuations on the two sides of Equation 10 must be approximately equal:

$$\overline{\text{DELTA } V(o,d)} / (E(V(o,d))+1) \text{ approx } = e(o,d)$$

Because the series expansion is about $E(V(o,d))$, by definition DELTA $V(o,d)$ is the fluctuation of $V(o,d)$ around its expected value, so its variance is the same as the variance of $V(o,d)$. What is more, the variance of $V(o,d)$ is $VAR(V(o,d))$ which, as was shown earlier, is approximated by $E(V(o,d))$. So, by well known statistical theorems:

$$(11)\ VAR(e(o,d)) \text{ approx } = E(V(o,d))/(E(V(o,d)) + 1)^2$$

Since Equation 8 shows that the $v(o,d)$'s are uncorrelated, an appropriate covariance matrix for GLS estimation of the parameters in Equation 1 is one that is defined using estimates of the expected values in the following:

$$(12)\ @E\ (T)(o,d) = \begin{vmatrix} D(0) & & & 0 \\ & \cdot & & \\ & & \cdot & \\ & & & \cdot \\ 0 & & & D(\cdot) \end{vmatrix}$$

It should be noted that the preceding discussion has implied that all use of a park during a given period is monitored. Usually, however, the total traffic flow (or the components of that flow) to a site from an origin is not observed but estimated. The dependent variable in a regression thus will likely be a function of $vv(o,d)$, a weighted sum of observations. Yet the fact that in a particular regression $vv(o,d)$ is the dependent variable presents no particular problem. One may simply use the variance in the $vv(o,d)$'s in a GLS regression by entering them in place of $E(V(o,d))$ in Equation 12. The weights $w(o,d,t)$ used to multiply the flows $v(o,d,t)$ to get $vv(o,d)$ can be usea to obtain the variance in $vv(o,d)$. Using both

the results presented in Equation 8 and the well known statistical theorems that deal with variance, it follows that if V is used as a notation to indicate survey observations with time in hours, days or some appropriate unit and if vv(o,d) = @E w (o,d,t) v(o,d,t) where the sum is over t, then:

(13) an estimate of variance in vv(o,d) =

$$@Ew^2 (o,d,t) vv(o,d,t) \text{ summed over all sample times}$$

Alternatively, if a survey design allowing variances in origin-destination visitor flow estimates to be calculated was used, the estimates obtained could be employed in defining the covariance matrix.

AN APPLICATION

The preceding discussion implies that it is appropriate (1) to accept the heteroscedasticity of variances in flows when using the ,'ogarithmic additive' model, and (2) in determining regression coefficients, to give larger weights to origins contributing large flows of visitors than to those that contribute small visitor flows to the total use of an area.

For reasons cited earlier, the covariance matrix of the observations used in making GLS estimates of the parameters of Equation 1 is essentially given in Equation 12. When the parameters in Equation 14 were estimated using GLS for the same set of data as used to derive Equation 1, the following equation was obtained:

$$(14) \log (V(o,d)+1/P(o)) = 3.13701 - 0.260 D(o,d)$$

The predicted numbers of visits from each origin to Rowan's Ravine and the percent of error between predictions and observations are presented in Table 1 as they were for the OLS regression. The R^2 attained was 0.87, which was up from 0.77. As in the OLS regression, the regression coefficients are highly significant. And, in this case, the standard error of the regression coefficient of D(o,d) was 0.00246. Comparing Equations 15 and 1, one sees that the coefficient of D(o,d) is relatively constant (at 0.02413 for OLS and 0.00246 for GLS). These coefficients also have small standard errors (0.00340 and 0.00246) in comparison to their actual values.

An obvious difference between the results of the two regressions is seen in Table 1. The residuals obtained using GLS regression range from 1 to 1,595, as compared to the residuals of the unweighted regression analysis which range from 1 to 2,978. But, because of the bias involved when antilogarithms of predicted values are taken to obtain estimates of the individual flows, it is not clear to what extent the larger residuals for the OLS regression are due

to model specification error, to measurement error and to "pure" logarithmic transformation bias.

One should recognize that GLS regression analysis resulted in an increase of percent error for some flows, such as those from observation units 5, 7, and 12. However, all of these flows are small compared to the flow from observation unit 4 to Rowan's Ravine. As one can see from Table 1, on the average the percent error in the individual flows was greatly reduced by using weighted (GLS) regression. Had a weighted average been used to compute average error, GLS results would have appeared even better. Observation 4, which contributed about sixty percent of the total visitor flow, had its error reduced from 103 percent to two percent. Regardless, whether a percent RMS error measure or variances of parameters is considered, the GLS model is superior to the OLS model. (See Table 2.)

AN 'ABSOLUTE' MEASURE OF MODEL APPROPRIATENESS

From a critical perspective, the model described in this paper has been assumed to be structurally sound. The wary reader may be disturbed by this assumption. Actually, the theoretical error distributions developed can be used to see if the observed residuals are distributed as they should be if the model is structurally appropriate for the data. The results already presented suggest that one consider:

(15) $X^2(M-N)$ approx = $(\text{residual})^2/E(V(o,d))$

overall o,d flows

WHERE M number of flows observed

N number of parameters estimated, and, for evaluating individual flows:

(16) $X^2(1)$ approx = $(\text{residual})^2/E(V(o,d))$

The rationale for Equations 15 and 16 is that for the distribution being considered, a residual squared divided by its variance is approximately the square of a normal zero-one variable. This is by definition a chi-square with one degree of freedom. It is recognized that the residuals are not orthogonal to each other since degrees of freedom are lost when parameters are estimated. So, in Equation 15, degrees of freedom M-N are suggested with N being the number of regression parameters. The authors believe that using observations as GLS weights does not result in the loss of further degrees of freedom.

Using Equation 16, it is possible to see that, over all, there are structural problems with the model. The large X^2 values in Table 3 actually make it clear that the model does not do as well as it should in explaining the observed flows. The X^2 M-N having a highly sign value, is "absolute"

TABLE 2

PERCENT ROOT MEAN SQUARE (RMS) ERROR
AND RELATED STATISTICS OF OLS AND GLS ESTIMATES

Error Measure	OLS	GLS	Improvement Factor GLS/OLS
% RMSE Error*	200.00	95.91	0.48
S.D. of b**	0.00783	0.00567	0.72
Average	-	-	0.60

* % RMS Error - (1/17 @E (% error of observation i)^2)1/2

WHERE percent error of observation i =

$$\frac{\text{observed visits - estimated visits}}{\text{estimated visits of observation}}$$

** It is recognized that estimates of the Standard Division in the regression coefficient, S.D. of b, is biased when OLS is used with heteroscedastic data. One can of course use the data provided to calculate an unbiased OLS estimate of the S.D. of b but it is not relevant to the problem under consideration. This is because the concern is with comparing a procedure accepting the OLS model with a GLS result.

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proof that the structure of the model used is not totally adequate to explain the observed flows so its value is an "absolute" criterion for the structural adequacy of a model. Obviously, several models could be accepted as structurally adequate and, if this is the case, then it is possible that the methodology of Smith (see Reference 12) should be employed to select one model as the best.

As well as recognizing that an overall structural adequacy test can be made, it should be noted that the very large x21 values associated with observation units 5 and 7 certainly reflect problems with the model used because those abserved for the origin-destination flows have essentially zero probability of occuring. However, careful examination of how origin areas 5 and 7 were defined and how the

distances from these areas to Rowan's Ravine were measured suggests that the poor agreement between predictions and observations is a result of D(o,d) being given a value that is smaller than the value it should have. Similar considerations allow one to understand other significant residuals. A table such as Table 3 has good information from which to improve a model and such a table should be computed as a routine part of analysis if a model is not structurally adequate.

CONCLUSION

This paper has dealt with obtaining efficient estimates of the parameters in an equation that defines a relationship between visitor flows and other variables. The rather obvious conclusion that has been reached is that, in regression analysis of flows using an equation such as Equation 1, greater weights should be given to the more accurate observations of visitor flows so that efficient flow and parameter estimates can be obtained.

A practical consequence of having more efficient estimates is that research costs can be reduced or planning accuracy improved without increasing existing data collection costs. The fact that, on the average, accuracy improvement was sixty percent (see Table 2) means that to achieve the GLS level of accuracy using OLS, about three times as much data, (1/0.60)2 =! 3, would be required. Since using GLS regression costs no more (or little more) than using OLS.

Finally, regarding point 3, it is admitted that in deriving the covariance matrices for v(o,d) and v(o,d,t), a number of assumptions were important in reaching the expressions derived. The validity of these assumptions about the behaviour of recreators must be checked. The specific concern must be whether probabilities that are assumed to be small are small. However, one should not make too much of this. As noted for point 2, small or even moderate errors (30 or 40 percent) in the variance elements of covariance matrix - errors due to poor approximations - have less effect on the parameter values estimated using the covariance matrix than one might expect.

In conclusion, an example helps illustrate the importance of having both efficient estimates and an absolute measure of a model,' structural adequacy. The work of Van Doren and Ellis cited early in this paper compares the 'goodness' of a gravity model and a systems model to explain trip distribution in Michigan. They show that a systems model is 30 to 40 percent 'more accurate' than a gravity model. But Van Doren used OLS in estimating the parameters of his gravity model. If Van Doren has used GLS he would have achieved about 60 percent improvement in accuracy and it would have been concluded that both models were equally good or that the gravity model was slightly better.

TABLE 3

COMPARISON OF RESIDUALS AND OBSERVED VALUES

Origin area	Predicted Flow	Residual (observed-predicted)	Residual Squared
1	22	14	196
3	66	-3	9
4	5,731	137	18,769
5	2,315	-1,595	2,544,025
6	1,001	969	938,961
7	1,614	-1,236	1,527,696
8	86	-50	2,500
9	98	1	1
11	16	2	4
12	601	-187	34,969
13	10	17	289
14	190	-127	16,129
15	38	88	7,744

Origin area	Est Use E1	Observ *** E2	Approx X^2	Probability Of the X^2 value
1	.38	.66	.39	*
3	1.13	1.98	.006	*
4	98.81	173.50	.14	*
5	39.91	70.08	49.11	**
6	17.43	30.60	41.50	**
7	27.82	48.85	42.30	**
8	1.48	2.59	1.30	*
9	1.68	2.95	.0004	*
11	.27	.47	.011	*
12	10.36	18.19	2.60	*
13	.17	.29	1.32	*
14	3.27	5.14	3.80	*
15	.65	1.14	9.18	**

* This value of X12 has a high probability of occuring as shown:

P(X12 J 3.84) = .05 P(X12 F .0039) = .05
P(X12 F .00063) = .02 P(X12 F .00016) = .01

** This value has a low probability of occuring by chance as shown:

P(X12 J 9) = .0027 P(X12 F 10) = .00157

*** E1 and E2 values are estimates of the observed weekday and weekend use respectively. These figures were used in calculating chi squared values because total use was estimated by:

Use = (18) (number of weekday questionnaires returned) + (27) - (number of weekend questionnaires returned)

So since it was known that for all handbacks: E1/E2 = 168/295 and the equation: predicted use = 18E1 + 27E2 were used to derive estimates of E1 and E2 for each observed flow. Then the variance in the use was calculated as described in the paper: Var(use) = (18)2E1 + (27)2E1 Thus X1 = (residual squared/variance (use)).

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It should also be noted that if a significant X^2 value of 'absolute' fit were found for one or both Michigan models, one would be forced to face the fact that neither Van Doren or Ellis had done that well in explaining behaviour. Certainly there is need to be more concerned with adequacy of model structure before comparing R^2's corrrelated measures to show that a model is better.

CORD STUDY TECHNICAL NOTE 35

STATISTICAL CONSIDERATIONS USING GRAVITY TYPE MODELS TO EXPLAIN VISITOR FLOWS

M.F. Goodchild

ABSTRACT

This paper reports on an inquiry into the problems of fitting aggregate spatial interaction models to empirical data. The concern is with flows of visitors to recreation sites from a variety of origins, and with the class of models for those flows, normally referred to as gravity models. The paper reviews the conventional approach to spatial interaction analysis, using standard measures of success. Then four basic problems are discussed in the context of a small data set. These relate to: non-linearity of models; integral values of visitor flows; volume of flow observed and goodness of fit; and the weak theoretical basis for the models used. Finally, the paper examines other problems which arise in more complex situations, and makes general recommendations.

The early sections on problems are statistical and will be of more interest to technical readers; later sections are more general, and the statistical results are restated non-technically in the conclusions.

INTRODUCTION

This paper reports on an inquiry into the problems of fitting aggregate spatial interaction models to empirical data. More specifically, it is concerned with flows of visitors to recreation sites from a variety of origins, and with the class of models for those flows, normally referred to as gravity models from a rather tenuous analogy to the Newtonian inverse square law of gravitational attraction.

The most general form of the gravity model is as follows:

$$I(i,j) = f(1)(P(i))f(2)(A(j))f(3)(D(i,j))$$

WHERE $I(i,j)$ is the flow from origin i to destination j,

$P(i)$ is a measure of the potential supply of visitors from origin i,

$A(j)$ is a measure of the attractiveness of place j,

D(i,j) is a measure of the trip from i to j, and

f(1), f(2), and f(3) are functions calibrated for a given activity and set of origins and destinations.

Since the early sections of the paper consider the problems of fitting models to a single destination, f2 can be ignored. Assume that P(i) is the population of the ith origin, that f1 is linear and that f3 takes one of the following forms: exp(bD(i,j)) or D(i,j)**b. Then there are two possible expressions of the general form presented above:

(1) I(i,j) = P(i) exp (a + bD(i,j))

(2) I(i,j) = P(i) a D(i,j)**b

While Equation 2 is the historic gravity model, recent studies have shown increasing interest in Equation 1, both on empirical and apriori theoretical grounds. (See References 11 and 63.) Furthermore, the algebraic difference gives rise to rather different methodological problems in each case.

There are several such problems. First, the non-linear form of both models means that if standard linear regression techniques are to be used in calibration, there must be a transformation of the variables, so that the results of the analysis appear in units which are often misleading, and which make comparison with the original data difficult. Second, visitor flows are composed of integral numbers of people. If flows are sampled over some limited time period and used as estimates of long-term interaction, then the sampling process will be quite different to that normally assumed in regression analysis. Third, the success of the analysis, or the degree to which the model fits the data, will depend on the length of the sampled period, so that the greater the total visitor flow sampled, the better the fit. Finally, gravity models have a rather weak theoretical basis. Such explanations as do exist (see References 41, 51, 63) contain strong assumptions which are easily broken in the real world, so that the model may suffer from structural inadequacies in specific situations.

The early sections on basic problems are statistical and will be of more interest to technical readers; later sections are more general, and the statistical results are restated non-technically in the conclusions.

THE CONVENTIONAL APPROACH

The data set used for illustration and simulation in this study is the one discussed by Beaman, Knetsch and Cheung (see TN 19). It gives the visitor flows to Rowan's Ravine Provincial Park in Saskatchewan, from seventeen origin areas (see TN 1). In the sampled period, the year

TABLE 1

ANALYSIS OF EQUATION 1

	a	b	R^2	PE***	RMS****
OLS	-.488	-.0547	.755 (.685)*	138.4	217.3
NLLS	-.812	-.0381	.755	75.0	108.7
WNLLS	-.365	-.0585	.296	191.8	337.7 (104.1)**
MIN PE	-.380	-.0449	.898	66.6	84.7
MIN RMS	.368	-.0495	.486	67.8	71.9

* R^2 given first for log I(i,j)/P(i), in parentheses for I(i,j)

** Figure in parentheses computed using weighted observations.

*** Mean absolute % error in flow.

**** Root mean square error in flow.

(OLS=Ordinary Least Squares; NLLS=Non-Linear Least Squares; WNLLS=Weighted Non-Linear Least Squares; MIN PE=Minimum Mean Absolute Percent Error; MIN RMS=Minimum Root Mean Square Error.)

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1969, there were 9,828 visitor vehicles, including 5,868 from the observation unit containing the city of Regina, and none from four of the areas. Following the earlier work, each observed flow has been arbitrarily increased by 1 when calibrating logarithmic models to avoid having to take the logarithm of zero.

The conventional approach to calibration is to transform the equations to linearity by taking logarithms. Equation 1 can be transformed as follows:

$$\ln (I(i,j)/P(i)) = a + bD(i,j)$$

and Equation 2 thus:

$$\ln (I(i,j)/P(i)) = \ln a + b \ln D(i,j)$$

so that both equations are of the form $y = c + dx$, and both involve two fitted constants. In the first, the negative

TABLE 2

ANALYSIS OF EQUATION 2

	a	b	R^2	PE	RMS
OLS	10965	−3.40	.767 (.344)*	111.7	141.5
NLLS	163	−2.01	.903	70.8	75.9
WNLLS	8770	−3.50	−.023	236.3	308.6 (93.0)**
MIN PE					
	30000	−3.42	−.020	46.7	59.4
MIN RMS					

* See footnotes to TABLE 1.

exponential case, ln (I(i,j)/P(i)) is regressed against D(i,j) to estimate values for a and b, while in the second ln (I(i,j)/P(i)) is regressed against ln D(i,j) to estimate ln a and b.

The results of these OLS, or Ordinary Least Squares regressions for the Saskatchewan data can be found in Figures 1 and 2. The R^2 values, describing the degree to which ln (I(i,j)/P(i)) can be predicted from D(i,j) and ln D(i,j), were .755 and .767 respectively, and the respective equation coefficients a and b can be found in Tables 1 and 2. Statistically, both analyses were highly significant and led to a confident rejection (at the 99.9% level) of a null hypothesis that the same R^2 values could have been obtained from a correlation of independent variables.

THE TRANSFORMATION PROBLEM

The largest residual observed in the negative exponential regression (Equation 1) was −3.477; in the power law regression (Equation 2) −3.670. In terms of the ordinate, ln I(i,j)/P(i), which ranged from −12 to 0, these residuals were not large and were visually acceptable (see Figures 1 and 2). But in terms of I(i,j)/P(i), in which the range is from .00001 to 1, the residuals represented an overprediction by a factor of roughly 40. Specifically, the observed flow I(i,j) for the point with the largest residual was 1; the first OLS model predicted a flow of 32.3, the second 39.3.

Residuals were then recalculated by taking the

Figure 1. Fits to Equation 1

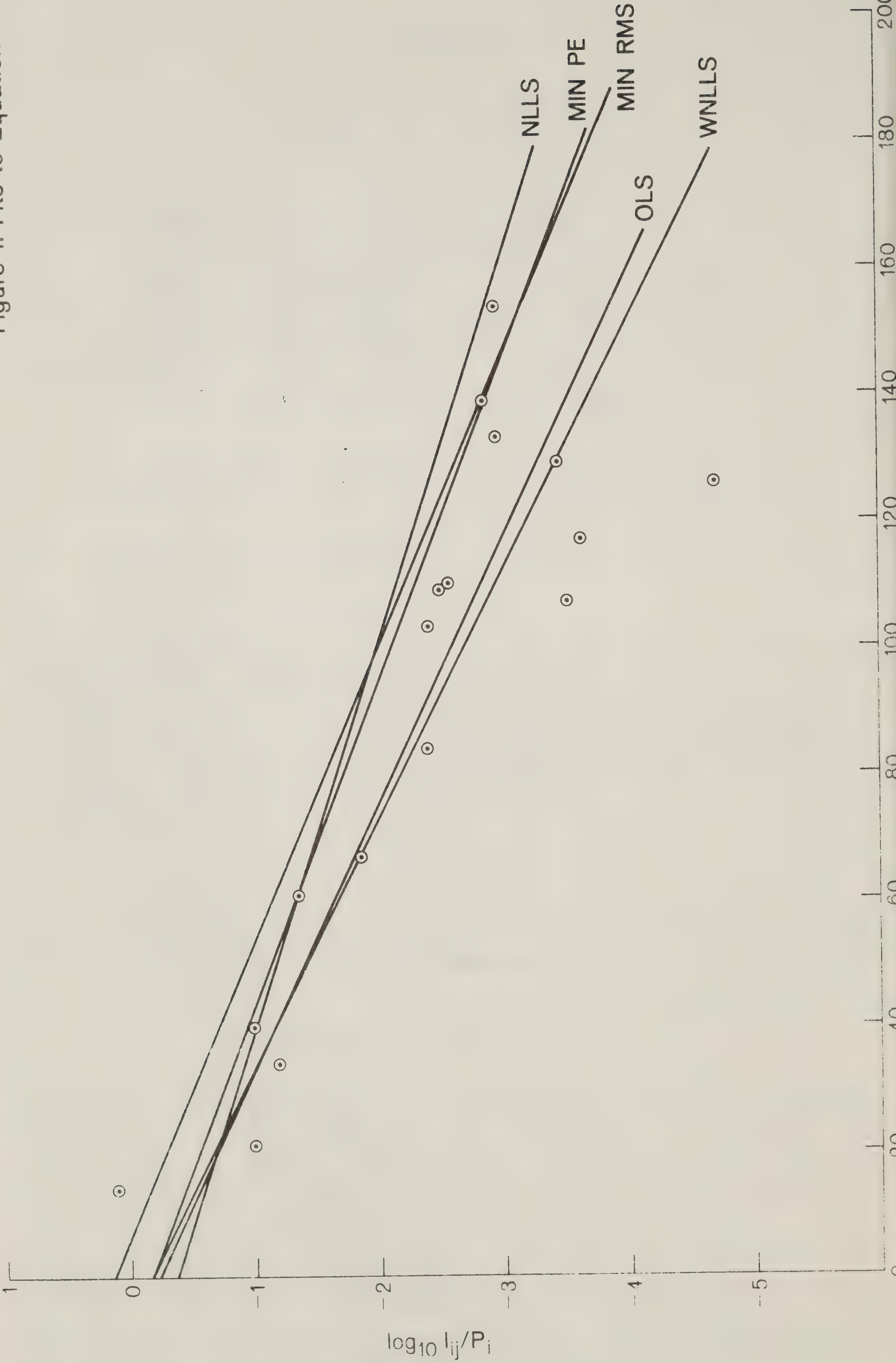
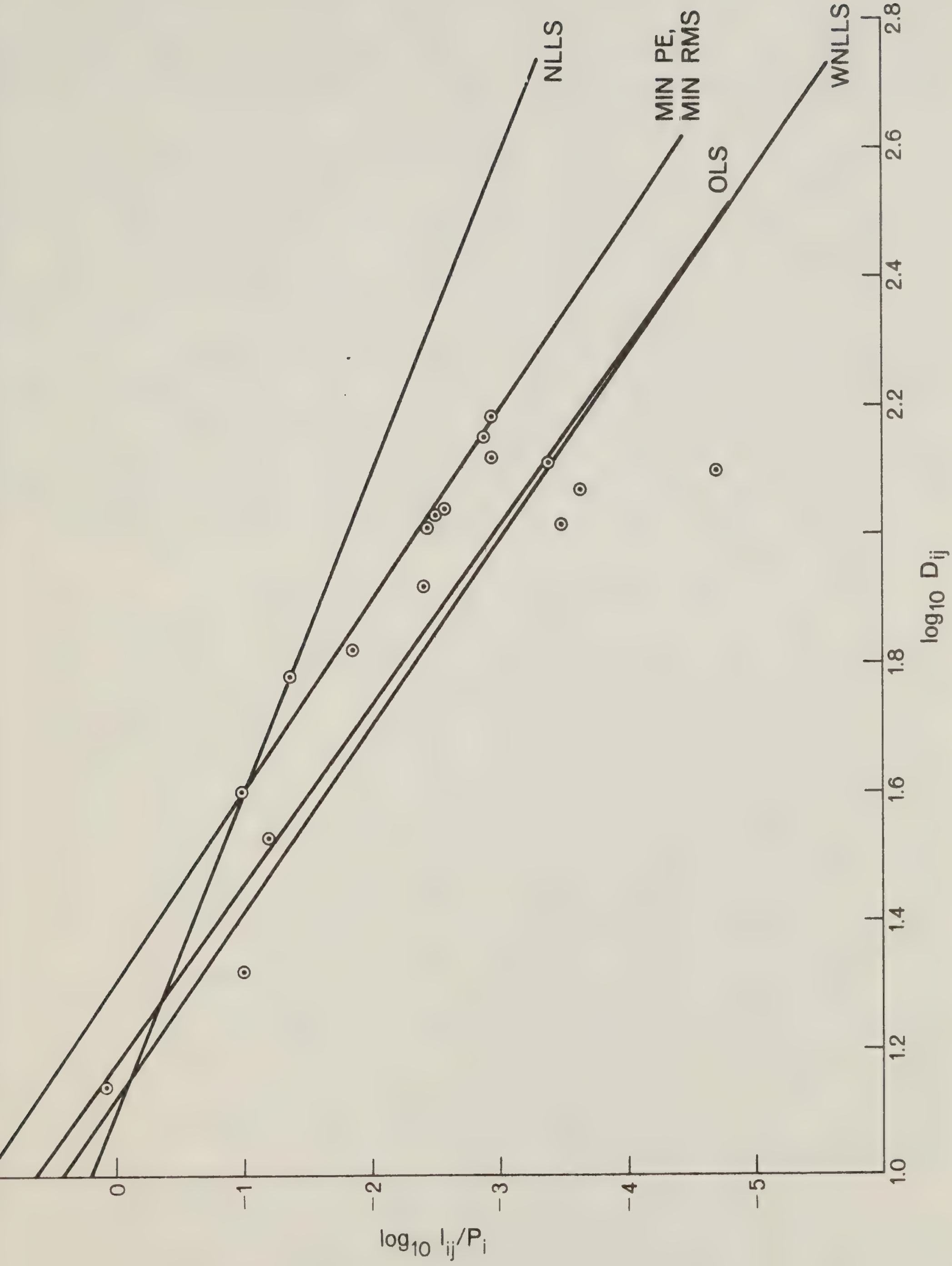


Figure 2: Fits to Equation 2



difference between the observed flow, and the flow predicted values of ln I(i,j)/P(i). Unlike the earlier values, these residuals will not sum to zero for either model. Equivalents to the earlier R^2 were calculated from the ratio of the sum of squared residuals to the visitor flow sum of squares for each model, to give .685 for the negative exponential and .344 for the power law. Clearly these models are much less successful if measured in terms of their ability to predict I(i,j) rather than ln (I(i,j)/P(i)).

Computing the difference between observed and predicted flows inevitably gives most weight to origins which contribute a high flow, and very little to smaller, more distant origins. Yet the planner who is interested in the proportionate difference between the observed and the predicted would give as much weight to a 10 percent error in a flow of 50, as to the same percentage error in a flow of 5000. Various authors have suggested that a percentage error in observed flows is a more useful measurement of residual variation in the recreation context (see References 16, 17) and have computed the root mean square percentage error (RMS) as a substitute for the conventional R^2 (see TN 19). The respective values of RMS error for the two models were 217.3 and 141.5, and the means of the absolute percentage error (PE) 138.4 and 111.7. Despite the high R^2 values, the predicted power of the models is rather weak when expressed in these terms.

A more direct approach to the fitting of the general model would be to avoid the logarithmic transformations altogether, and fit Equation 1 and 2 by a least squares procedure, directly minizing the sum of squared differences between observed and predicted flows. This was done using a combination of Gaussian and Steepest Descent methods to minimise the objective and the relevant statistics are shown in Tables 1 and 2 for comparison with OLS. This procedure will be referred to as NLLS, for Non-Linear Least Squares. Cesario (Reference 11) has discussed a similar approach. (The widely available TSP (Time Series Processor) package was used for least squares procedures, running in a CDC Cyber 73 under Scope 3.4. A listing of the TSP source program is available from the author.)

There is a marked reduction shown in both RMS and mean absolute error (PE) and although the R^2 values should not be compared to those derived from the OLS models, they can reasonably be compared to the recomputed values based on flows which are shown in parentheses. It is clear that the use of logarithmic transformations can seriously reduce the validity of gravity-type models, when validity is defined by RMS or PE error measures.

If it is argued that the RMS or PE measures are the most effective in the planning context, then ultimately the most satisfactory way of fitting or calibrating a flow model must be by direct minimisation of these criteria, rather than the conventional sum of squared residuals. In fact for this particular data set the degree of improvement is not great. The minimum mean absolute percentage error resulted

when predictions were made using the equations:

$$I(i,j) = P(i) \exp(-0.380 - 0.0449\, D(i,j))$$

$$I(i,j) = P(i)\ .30000\ D(i,j)^{(-3.42)}$$

and while the second equation also minimised the RMS error for the power law, the negative exponential was calibrated with a = 0.368 and b = -0.0495 on this criterion. The accompanying statistics are shown in Tables 1 and 2 as the MIN PE and MIN RMS procedures. (The approach used an interactive procedure in which the user can watch the performance of a general objective function as each constant is incremented over ranges prescribed by the user. The routine was written by the author for the PDP10. Typically 15 minutes of terminal session are required to examine one objective.)

For comparison, the above equations are plotted in Figures 1 and 2 with the results of the earlier procedures. They do not have the same visual impact as the OLS equations, which pass neatly through the points, since their objective functions and residuals are based on I(i,j) and thus only indirectly related to the ordinate log (I(i,j)/P(i)).

THE HETEROSCEDASTICITY PROBLEM

In using the linear regression model, one makes the assumption that residuals are independently distributed with a constant variance. In terms of the interaction model transformed by taking the logarithm of I(i,j)/P(i), each observation is assumed to be subject to the same residual error distribution, or in terms of I(i,j)/P(i) - to the same proportionate error. If ln (I(i,j)/P(i)) is assumed to have normally distributed errors, so that errors in I(i,j)/P(i) will be lognormal, or normal when expressed as proportions one has a model for usual linear regression.

In reality, this model is quite inappropriate to the expected distribution of I(i,j). If the observed visitor flow is the result of a very large number of samplings of the origin population under a very small probability, then I(i,j) can be expected to follow a Poisson distribution (see TN 19). In other words, its distribution is discrete and non-normal, with a variance which is equal to its expected value, and thus varies from observation to observation. The variance in ln (I(i,j)/P(i)) is compounded by the distribution of P(i), and clearly violates the homoscedasticity assumption of OLS.

Beaman et al. (see TN 19) have calculated the variance in ln (I(i,j)/P(i)) as approximately proportional to 1/I(i,j) by expanding the logarithm function in a Taylor series. (The error variance of ln (I(i,j)/P(i)) clearly depends on the value of P(i). Beaman et al. made the implicit assumption that P(i) is constant in their Equation

9.) Thus the high-flow observations are subject to a much smaller error variance and merit much greater weight in the regression. Beaman et al. used a generalised least squares procedure (GLS) weighted by the inverse of the variance estimates to fit the logarithmic transformation of Equation 1.

A similar approach can be taken in the direct, non-linear regression. If we assume a Poisson distribution, the error variance of I(i,j) in Equations 1 and 2 can be taken as I(i,j) itself. Then the appropriate weighted least squares criteria are:

$$\text{Minimize } @E\ (I(i,j)-P(i)\ \exp\ (a+bD(i,j)))^2/I(i,j))$$

and

$$\text{Minimize } @E\ (I(i,j)-P(i)\ aD(i,j)^{**}b)^2/I(i,j)$$

These criteria give the greatest weight to the smaller flow values, since in terms of I(i,j) these are the most reliable, whereas for the logarithmic regressions it was the high flow values that had the least error variance and the greatest weight. The criteria are quite similar to those for the direct minimisation of RMS error:

$$\text{Minimize } (1/n\ @E\ (I(i,j)-P(i)\ \exp\ (a+bD(i,j))^2)/ (P(i)\ \exp\ (a+bD(i,j))^2))^{**}(1/2)$$

and

$$\text{Minimize } (1/n\ @E\ (I(i,j)-P(i)a\ D(i,j)^{**}b)^2/ (P(i)\ aD(i,j)^{**}b)^2)^{**}1/2$$

WHERE n is the number of points

except that the denominator is formed from the predicted rather than the observed flow.

Again, the results are shown in Tables 1 and 2 and Figures 1 and 2 for comparison with the earlier procedures. Error measures were computed without observation weights.

In both cases there is a considerable deterioration in the degree of fit reflected in the error measures. The corresponding weighted RMS figures are 104.1 and 93.0 respectively, and give a fairer representation of the degree of fit. But as would be expected, in neither case do the figures approach those for a direct minimisation of RMS error.

It is intuitively reasonable to weight observations in inverse proportion to their error variance. Since the error variances are known from theoretical arguments, it is possible to make corrections for heteroscedasticity by weighting observations. But in reality the observed error variance is composed both of a Poisson-distributed part and a component due to structural inadequacies in the model, with an unknown distribution. Further, the data also violates several other assumptions. Errors are not normally

distributed: when expressed as small visitor flows they are Poisson, with a highly skewed discrete distribution, and when expressed as log I(i,j)/P(i) they are compounded by the distribution of P(i). Further, because the values of the variables themselves are not sampled from a bivariate normal distribution in any of the models, questions of statistical inference and parameter estimation are discussed in the next sections through the results of Monte Carlo simulations.

SIMULATION TECHNIQUES

The models under examination involve three "sampled" variables, I(i,j), P(i) and D(i,j). But of these we may assume that D(i,j) and P(i) are known to considerable accuracy, and that all error is concentrated in I(i,j). Thus error will be of two types: a statistical component due to the use of a flow value sampled over a limited time period as an estimate of a long-term average flow; and a systematic component due to the structural insufficiency of the model in explaining visitor flows.

In the next two sections, the results of simulations of the statistical error component in the Saskatchewan data set are discussed with two objectives. First, it is possible to simulate the sampling distributions of the important regression parameters and so gain a more quantitative notion of the relative importance of the statistical and structural components. Second, simulation can establish the importance of sample size in parameter estimation. Because of the complexity of the error distribution, the results will be specific to the data set and only qualitative generalities can be expected.

The distribution of I(i,j) is assumed to be Poisson for a given observation. I(i,j) is an unbiased, maximum likelihood estimate of the Poisson density parameter m such that:

P(r) = m[r] exp (-m)/r!

WHERE P(r) is the probability that a Poisson process of density m will generate exactly r events in a trial.

To simulate the effect of statistical error, the observed visitor flows were used as estimates of m, and for each simulation run, each flow was independently replaced by a random Poisson deviate of that density. Thus the range of parameters found for models fitted to this simulated data will represent the range of uncertainty attributable to statistical error.

Two methods were used to generate the deviates, an exact method for m less than 30, and an approximation above that value. In the exact method, a single random number was generated in the interval 0 - 100. Poisson probabilities were calculated from r = 0 until the cumulative total reached the random number, treated as a percentage, and the

corresponding value of r became the Poisson deviate.

The approximate method used two standard statistical relationships. First, the probability that a Poisson process of density m will generate a number less than r is identical to the probability that a X^2 process with 2r degrees of freedom will generate a number greater than 2m (see Reference 34). Second, the X^2 distribution is approximated by a unit Normal distribution for large numbers of degrees of freedom:

N(0,1) = $(2X^2)$**1/2 - (2V-1)**1/2

Normal deviates were generated by the method described by Box and Muller (Reference 5), in which two independent random numbers, uniformly distributed in the interval 0 - 1 (Rl and R2), are combined to give two independent random numbers with an approximately unit normal distribution (N1 and N2):

N1 = (-2 ln R(1))**1/2 sin (2 PI R(2))

N2 = (-2 ln R(2))**1/2 cos (2 PI R(1))

Then the normal deviates were converted to a Poisson distribution via X^2.

DISTRIBUTION PROPERTIES

Two types of simulations were made, one using real visitor flows as the basis of simulated flows, and the other using predicted flows from the OLS negative exponential model as the basis. The results of the first series of experiments are shown in Table 3. Twenty-four runs were made, and analysed using the three models based on the negative exponential; the Ordinary Least Squares procedure using ln (I(i,j)/P(i)) as the dependent variable (OLS), the direct least squares calibration of Equation 1 (NLLS), and the latter using weights estimated from the predicted error variances (WNLLS).

The results show that for this data set, statistical error is very much less important than structural error. For the OLS case, the standard error of the _ coefficient in the original calibration of the model was estimated to be .00803. Yet successive simulations of statistical errors produced a range of _ coefficients with a measured standard deviation of only .0005. Similarly, the variation in R^2 as a result of simulation suggests that the major source of unexplained variance is structural. Again, the regression standard error in the _ coefficient is .808, compared to a standard error in simulation runs of .046.

Results are very similar for the non-linear regression. The skewness in the RMS and PE distributions is largely removed, and the consequent bias in single estimates is reduced. Again, the estimates of a and R^2 are remarkably

TABLE 3

FIRST SIMULATION EXPERIMENTS

	a	b	R^2	PE	RMS
OLS					
Actual	-.488	-.0547	.755	138.4	217.3
Simulation	-.489	-.0547	.754	140.2	227.7
Std Error	.046	.0005	.010	5.3	16.6
NLLS					
Actual	-.812	-.0381	.905	75.0	108.7
Simulation	-.814	-.0382	.902	75.1	109.2
Std Error	.047	.0011	.010	2.2	3.4
WNLLS					
Actual	-.365	-.0585	.296	191.8	337.7
Simulation	-.378	-.0585	.289	196.4	347.6
Std Error	.054	.0005	.024	15.2	38.6

TABLE 4

SECOND SIMULATION EXPERIMENTS

	a	b	R^2	PE	RMS
OLS					
Actual	-.488	-.0547	1.000	0.0	0.0
Simulation	-.528	-.0546	.984	20.6	29.3
Std Error	.089	.0019	.010	5.2	7.2
NLLS					
Actual	-.488	-.0547	1.00	0.0	0.0
Simulation	-.536	-.0538	.999	20.0	29.1
Std Error	.049	.0010	.001	5.5	6.8
WNLLS					
Actual	-.488	-.0547	1.000	0.0	0.0
Simulation	-.505	-.0548	.984	21.1	30.7
Std Error	.072	.0015	.015	7.3	9.0

<><><><><>

precise, although there is a slight increase in the standard error for the b coefficients. This is somewhat offset by a proportionate reduction in the standard error of a. On the other hand, the weighted regression results revert to the pattern shown by OLS, giving slightly better estimates of b

and biased estimates of RMS.

The second set of simulations show the amount of error introduced into a perfectly predictable set of data by adding Poisson-distributed errors to visitor flows (Table 4). They show that the statistical error component has relatively little effect on error statistics by itself, so that the vast majority of the error observed in the original data must by structural.

PE and RMS errors are remarkably independent of the method of calibration when structural error is absent, while R^2 is more sensitive to the statistical error component in OLS and weighted non-linear (WNLLS) regressions. Standard errors of the coefficients tend to be rather higher than they were in the first set of simulations with real data, except in the case of NLLS.

The above simulations, particularly the first set, provide a rapid method of evaluating the relative importance of statistical and structural error in the calibration of a spatial interaction model. Because of the dependence of the result on the specific configuration of the data set, and the immense difficulties of any analytic approach, it is suggested that such Poisson simulations be incorporated into any calibration of this type of model, particularly in cases where samples are small, and statistical error correspondingly high.

AGGREGATION EFFECTS

Sample size will affect the calibration of a spatial interaction model in various ways. The statistical error component has known properties, if we can continue to assume that its distribution is Poisson, so that the error variance in observed flows will increase in direct proportion to the length of time sampled. The standard deviation will be proportional to the square root of sample size, so that it will decrease in proportion to the observed flow as sample size increases.

While statistical error may be well understood, there is no similar basis for assumptions about structural error. In one particular case, structural error might appear as a normally distributed residual, as a result of other, external effects on visitor flows. In another case, structural error might be the results of a misspecification of the functional form of the model, perhaps in the effect of distance. It would seem reasonable on dimensional grounds to assume that the standard deviation of the structural error term will be in constant ratio to the observed flow, and thus rise in direct proportion to sample size. Thus

I(i,j) = {I}(i,j)+c(1) (I(i,j))**1/2 +C(2)I(i,j)

WHERE {I}(i,j) is the expected flow in
the sampled interval;

C(1) I(i,j)**1/2 is the statistical error component;

C(2) I(i,j) is the structural componet.

STRUCTURAL ERROR

The gravity model is a purely inductive device, open to charges of curve-fitting which can only be countered by relating the excellent degrees of fit invariably obtained. The first part of this paper has concentrated on two problems encountered in calibrating the model: variations in performance between different procedures; and effective measurement of the goodness of fit. But while it is possible to evaluate the relative importance of statistical and structural error, and to make allowances for the latter, it is clear that the existence of the structural component represents an important deficiency in the model.

Any approach to the reduction of structural error must begin at the theoretical level with a discussion of the basis for the model's excellent fit to reality. The literature offers two major classes of explanation, first through hypotheses made at the aggregate level, and second through hypotheses about the behaviour of individuals in the system.

AGGREGATE THEORIES

Wilson (see, for example, Reference 63) has shown that under certain assumptions, trips made in a completely random way between origins and destinations will aggregate so that the total interaction between origin i and destination j is given by:

(3) I(i,j) = ko kd O(i) D(j) exp (-bc (i,j))

WHERE O(i) is the total flow from i,

D(j) is the total flow to j,

c(i,j) is the cost of one trip, and

ko, kd and b are constants,

which is algebraically similar to Equation 1.

The method can be called an entropy maximising strategy because there is a useful analogy to Boltzmann's statistical thermodynamics. Suppose the I(i,j) are known so that a table can be constructed to show the flows between each origin and each destination. It is possible to calculate the number of ways in which specific individuals can be assigned to specific flows, given the table of totals along each

path. For example, if all individuals are in origin 1 and travel to destination 1, then only one arrangement of individuals is possible, while if trips occur between multiple origins and destinations there are many ways in which the individuals can be rearranged without changing the totals.

Not all patterns of flows are possible. The total flow from origin i must equal O(i), and arrivals at j must equal D(j). Wilson introduces a further constraint that the total cost of all trips made in the system be C.

In a purely random world, in which no behavioural rules exist other than the constraints, it is reasonable to assume that all possible arrangements of trips are equally likely. This means that it is possible to calculate the probability of each pattern of flows from the numbers of alternative arrangements of individuals associated with each pattern, and to find the most likely pattern. The result is Equation 3. Provided the number of individuals in the system is large, this most likely pattern proves to be so much more likely than any other that it is possible to predict with some confidence that it will be the one found in reality.

There are three major ways in which structural inadequacies can arise in Wilson's analysis, and be reflected in structural errors in the model. First, the model invokes what is sometimes known as the Principle of Insufficient Reason (see Reference 31) and assumes that all arrangements of individuals are equally likely. This will be untrue if, for example, certain kinds of individuals show a preference for certain types of trips, or if a set of individuals is associated with a particular origin and may only make trips from that origin. Second, the constraint that the total cost be C may not reflect behavioural reality. It is more likely that total cost fluctuates as the sum of a number of fluctuating individual expenditures. Third, behavioural traits may take the form of further constraints which limit the set of possible arrangements, and may lead to different conclusions.

BEHAVIOURAL THEORIES

In principle, a theoretical base could be established for the gravity model if it could be shown that a large number of individual actions, each made according to some general rule, would combine to produce aggregate flows which were in agreement with the model. Ewing (Reference 18) discusses some of the relevant problems. In essence, in order to aggregate behaviour in which distance appears as at least a partial criterion, one must assume some kind of geometrical arrangement of origins and destinations, and so the aggregate flows will be unique to the geometry. It is possible for behaviour according to a general principle to combine with a specific geometry to produce a specific aggregate pattern, and it is conceivable that a specific behavioural principle might combine with a specific geometry

to produce a general aggregate pattern, fitting the gravity model. But there is a logical impossibility in conceiving of a general behavioural rule which would give a general aggregate pattern independent of the specific geometry - and there is no general principle of human geometry.

Niedercorn and Bechdoldt's analysis (Reference 43) has received a great deal of attention. They consider a single individual in origin i, and the set of trips that he or she makes through time to various destinations j. Each trip will have a certain utility to the individual, which is assumed to depend on the number of purposes which are satisfied by the trip, which in turn is assumed to depend on some attribute of the destination, depending on the context. Each trip has an associated cost, and the individual is assumed to be constrained by a travel budget. Under these conditions, the pattern of trips that maximises the total utility to the individual is shown to be of the form of Equation 2, under specific assumptions about the utility function.

When aggregated, Niedercorn and Bechdoldt's analysis is capable of predicting the relative magnitudes of flows from a single origin. In a system of many origins and destinations, it predicts that the flows from a single origin will be proportioned in a way which is compatible with the gravity model, but the relative magnitudes of flows from different origins will depend on the geometrical arrangement of destinations around each origin and so can only be in accordance with the model in specific geometrical situations.

DYNAMIC ATTRACTIVITY

One characteristic of the model which has not so far been important is that the independent, predictor variables are usually assumed exogenous with constant values determined from physically measurable parameters. The analysis in the earlier sections was in the framework of a single destination. The model differentiates multiple destinations both on a geometric basis through D(i,j) and through the parameter A(j), the factor which explains differential flows when distances are constant. To some extent A(j) will be exogenous, related in the recreation context to the physical characteristics of a site and its immediate surroundings. But in most cases A(j) will also be related to the use that site i is actually experiencing, and thus be at least partly endogenous. A feedback loop will operate to make the site less attractive when the use is heavy, and perhaps also when it is excessively light.

The existence of dynamic determinants of attractiveness in an interaction system is not necessarily a source of structural error. Provided A(j) is regarded not as an exogenous variable but as a parameter that can be expected to change whenever the set of I(i,j) changes, then no contribution to structural error will result. But as such,

the model will have no predictive power. Structural errors will occur under sets of hypothetical flows unless the A(j) are themselves modelled in terms of the determining flows and exogenous physical parameters. Cesario (Reference 11) refers to this as Stage II of a spatial interaction analysis.

MINIMIZING STRUCTURAL ERRORS

Both of the above sources of structural error can be minimised by an appropriate modelling procedure. Suppose that it is possible to assume that any set of individuals, when presented with a set of parks of given attractiveness at given distances, will proportion themselves in the same way, regardless of how many other alternative destinations exist. In effect, this is the Luce choice axiom (see Reference 40). Attractiveness may itself be dynamically related to use, and the actual flows from the origin to any site will depend on the alternatives available: the hypothesis concerns the relative proportions only.

The hypothesis can be written as follows:

$$\frac{P(\longrightarrow i|j \longrightarrow)}{P(\longrightarrow k|i \longrightarrow)} = \frac{f(A(j),\ D(i,j)}{f(A(k),\ D(i,k)}$$

OR

$$P(\longrightarrow j|i \longrightarrow) = \frac{f(A(j),D(i,j)}{\text{@E}\ F(A(k),D(i,k))}$$

WHERE $P(\longrightarrow j|i \longrightarrow)$ is the probability that an individual, having left origin i, will go to destination j, and (k indicates the sum over all destinations available from origin i. In other words, the relative proportions visiting j and k are determined by the relative values of some function of attractiveness and distance for each destination.

Now the probability that an individual resident at i will make the trip to j is:

$$P(i \longrightarrow j) = P(i \longrightarrow)\ P(\longrightarrow j|i \longrightarrow)$$

WHERE $P(i \longrightarrow)$ is the probability of leaving i to go anywhere. Thus

$$\begin{aligned} I(i,j) &= P(i)\ P(i \longrightarrow j) \\ &= P(i)\ P(i \longrightarrow)\ F(A(j),\ D((i,j)/ \\ &\quad \text{@E}\ F(A(k),\ D(i,k) \end{aligned}$$

Then the flow from the origin to the jth site will be of the form

$I(i,j) = E(i)\ f(A(j),D(i,j))$

WHERE E(i) is a parameter which depends on the alternatives available from origin i as well as on p(i). Provided E(i) and A(j) are regarded as parameters unique to the given flows and systems geometry, then, and not equated with P(i) or with observable properties of the site, neither source of structural error need exist. If the model remains inadequate, it must be because incorrect assumptions are made about the function f, or because the Luce choice axiom does not hold.

PERIPHERAL PROBLEMS

The total use of Rowan's Ravine Provincial Park in 1969 amounted to 9,828 vehicles, or more properly their occupants. None of the modelling procedures recognised this as a constraint. In linear regression, it is true that the sum of predicted values equals the sum of observed values, but not in non-linear regression or in cases where a linear model is fitted to transformed data. Boyet and Tolley (Reference 6) recognised this problem, but it is difficult to deal with in the standard methodological practice.

In Wilson's analysis (see Reference 63) there are constraints both on the total arriving at a destination, and on the total leaving an origin, since ko and kd are not fitted parameters, but are solved for in the constraint equations. Iterative methods have been developed for fitting the model so that predicted and observed flows will obey the same constraints.

SUMMARY

The points raised in the paper can be divided into two groups. First, there are statistical issues involved in the fitting of models of the form represented by Equations 1 and 2 to spatial interaction data. The conventional method of least squares on transformed variables does not give the "best" fit to the model as that term would be understood by a recreation planner; the method does not minimise discrepancies between flows observed and those predicted by the model. The conventional measure of success is based on transformed variables, and shows quite different results when recomputed for the fit between observed and predicted flows.

Second, several points were made about the structural validity of spatial interaction models, and the generality of model parameters. The paper outlined the conditions under which the model could be consistent with underlying general principles of human spatial behaviour, and thus regarded as a general model.

THE MEANING OF R^2 IN USING ANALYSIS OF VARIANCE TO EXPLAIN PARTICIPATION IN RECREATION ACTIVITIES

M.F. Goodchild

ABSTRACT

The probability of an individual's participation in a recreation activity has been modelled as a linear combination of socio-economic variables, or traits. Such models are calibrated by using as the dependent variable a binary observation of whether each individual did or did not participate in the activity.

The R^2 statistic for these models is shown to be dependent only on the statistical relationship between probability and binary observation, and in no way on the validity of the model. Estimates of coefficients are unbiased but standard errors are overestimated.

An alternative index is proposed and demonstrated by simulation.

BACKGROUND

CORD Study Technical Notes 6, 12, 13 20, and 29 examined the use of analysis of variance as a method of modelling participation in recreation activities. Briefly, it was argued that in order to project demand for a given activity in a community, a model must incorporate shifting socioeconomic patterns. Rising incomes and aspirations create changes in leisure habits which in turn are reflected in varying patterns of demand for both indoor and outdoor activities.

The model proposed characterizes an individual by a bundle of socioeconomic variables, and postulates that some combination of these determines the probability of participation in a given activity by that individual:

p= a(0) + @E a(i)x(i)+ ε

WHERE (ε) is an error term, to be discussed below,

a0..a(m) is a vector of constants,

x(i) is the value of the ith socioeconomic variable, and

m is the number of such variables;

and the summation is over m.

In many cases the values of x(i) will be restricted to 1 or 0, corresponding to the individual's possession of the ith socioeconomic trait, or his lack of it, respectively. (TN 12 used the terminology of the analysis of variance, since all socioeconomic variables were considered as binary traits. The terms and symbols used in this paper are those of multiple regression, since many of the conclusions apply equally to independent variables measured on continuous scales. The Time Series Processor (TSP) was used for all simulations, in conjunction with small FORTRAN routines for data generation and post-TSP analysis.)

To predict and project participation levels in a community as a whole, the model is simply summed over the members of the community;

E(n) = @E Pi(j)
      = @E a(o) + @E @E a(i)x(i,j)+ @E &(j)
      = Na(o) + @E a(i)n(i) + &'

WHERE E(n) is the expected number of participants,

N is the population of the community,

n(i) is the population having the ith trait, and

j represents a single individual;

@E Pi, a(o) and &(j) is over n, and

@E @E a(i)X(i,j) is over N and M.

TN 12 illustrates the calibration of the model against the results of a survey of individual participation, and the use of the model in projecting recreation demand. The present paper examines a series of problems in the use of the model, and in the interpretation of the results, concentrating on the disappointingly low R^2 values, or measures of the model's fit to reality, that are customarily obtained.

THE BASIS OF THE PROBLEM

In calibrating the model, the dependent variable is not an observation of the probability p that an individual will participate, but an observation of the individual's actual behaviour. If the individual was observed to participate, the dependent variable is given the value of 1, and if not, 0. The relationship between this dichotomous variable and the probability p, is statistical: the probability that a 1 will be observed in a single trial is p, and that a 0 will be observed, 1-p.

The effect of calibrating with the dichotomous

variable, which will be referred to as y, rather than p, can be thought of as the addition of another error term to the model. The conventional error in p, which was introduced in Equation 1 as (e), will be referred to as structural error, while the second source introduced by using y as the dependent variable will be called statistical error. While structural error is an empirical quantity, statistical error should be perfectly predictable.

Suppose that structural error is absent, so that the entire error in the model is due to the statistical component. Consider a very large sample, and let the distribution of p values be such that the probability of finding a case in the interval p to p + dp is f(p)dp. Since p must lie in the range 0 to 1 it must be true that:

ł(F(p),dp) = 1

WHERE the integration is over 0 to 1.

The probability of observing y to be 1 is p, and 0, 1-p. With a sample of N, the expected number of observations for which y = 1 will be Npf(p)dp, and for y = 0; N(1-p)f(p)dp. So the observed sum of squared deviations between y's and p's, or between observed and predicted values of the dependent variable, will be:

ł(Npf(p) **(1-p)^{2}dp +aNF(p)**(1-p) P^2,dp = Nf(p) p(1-p)dp

The total sum of squares for all such intervals will be:

ł(Nf(p) p(1-p)dp)

(integrating from 0 to 1)

which is thus the sum of squares of y's about p's.

The total sum of squares for the dependent variable y about its own mean is:

ł(NpF(p)dp)-(łNpF(p)dp))^2/N

(integrating from 0 to 1)

Thus the value of R^2 that will be observed in the absence of structural error has an expected value of:

(k2 - k1^2)/(k1 - k1^2)

WHERE

k1 = łpf(p)dp and
k2 = łp^{2}f(p)dp

(integrating from 0 to 1)

So the asymptotic value of R^2 due to the statistical error component can be predicted from the first and second moments of the distribution of p. Consider a simple example. Suppose that the model predicts only two values of p, 0 and 1. That is, under certain socioeconomic conditions, individuals will certainly participate, and under all other conditions will certainly not.

Suppose that the probability of either condition occurring is 1/2.

Then $k1 = 1 \times 1/2 + 0 \times 1/2 = 1/2$

$k2 = 1^2 \times 1/2 + 0^2 \times 1/2 = 1/2$

$R^2 = 1$

Since p is restricted to 0 and 1, the y's must be respectively 0 and 1, there is no statistical error, and the fit is perfect.
Now let the two equally likely combinations of independent attributes give rise to p values of 1/3 and 2/3. This time statistical error is present, and R^2 deteriorates dramatically;

$k1 = 1/2$; $k2 = 5/18$; $R^2 = 1/9$

The foregoing discussion is of course limited to the asymptotic case. In principle, it is possible to calculate the distribution of R^2 for samples of limited size, but the tractability of the problem will depend very much on the distribution of p, and therefore on the empirical x(i) and a(i). For this reason the developments which follow are based on simulation of a few realistic cases, rather than on general mathematical analysis.

NATURE OF THE STRUCTURAL ERROR TERM

Many factors influence the likelihood of an individual's participation in an activity besides the socio economic traits x(i) included in the model. These include the effects of varying levels of the supply of opportunities for recreation (see TN 29), of the individual's own learning process, and of attitudes and perceptions. Furthermore, the model may not include interaction effects between two or more traits. Thus, it may be assumed that education is uniformly influential as a trait regardless of the presence or absence of other traits. But education may take part in interactive effects with other factors. If, for example, university education affects a certain participation probability only when coupled with high income, its influence will go undetected and appear in the error term, along with any other such interaction effects, or may actually distort the model. The point has been dealt with in detail in TN 20.

It is possible, then, to conceive of a variety of models for the error term in Equation 1 (for one type of error, see the Cicchetti and Smith article attached as an appendix to this volume). It might be simulated as an interaction effect by taking a certain value when both of two interacting traits are present, and zero otherwise. The error term due to supply and learning factors might be appropriately modelled by the conventional regression error term, an independent, normally distributed variate of zero mean. The latter approach was taken in the simulations which follow.

While the range of empirical P values is clearly restricted to between 0 and 1, there is no explicit requirement that the coefficients of the model be selected so that all predicted values of p lie in that range. In simulation experiments, it is quite likely that p will be driven above 1 or below 0 by the addition of large error terms.

In calibrating the model in other CORD studies this problem has been dealt with by the use of a modified regression procedure which restricts predicted p values to the prescribed range. In these simulations the range has been restricted by truncating any error which would otherwise have driven a p value above 1 or below 0. But in the long term, the problem would be better dealt with by a respecification of the model. Suppose that Equation 1 were to become:

P = (1/PI) arctan (a0+ @E a(i)r(i)+ε)+1/2

Then the limits p = 0 and p = 1 would become asympotes such that even the most favourable or unfavourable combinations of trait variables never quite result in inevitable behaviour, and no restrictions are placed on the values of the a(i) or ε. Calibration of the specified model is more difficult, because in the appropriate linearized form all values of the dependent variables y become ± infinity. But it would be quite possible to calibrate the model in the non-linear form given above by an appropriate iterative procedure.

SIMULATIONS (1)

The simulations were made with a set of nine independent, binary socioeconomic trait variables. Each one was simulated by generating a uniformly distributed random number in the interval 0 to 1, and then rounding to an integer, so that in each case the probability of the trait being present was 1/2.

p values were calculated from Equation 1 with all constants set ot 0.1. The ε values were normally distributed with mean 0 and with standard deviation @E determined for each simulation, so that the amount of structural error could be varied freely. The method of Box and Muller (see

Reference 5) was used to generate normally distributed deviates from pairs of random numbers in the interval 0 to 1.

y values were generated from the p's according to the value of a further uniformly distributed random number in the interval 0 to 1. If this number was greater than p, y was set to 0, and vice versa.

The first set of simulations demonstrates the dependence of R^2 on statistical error when structural error is absent. The results are shown in Table 1. In each case the fitted vector of coefficients was compared to the original set used to calculate p values. The deviations were expressed in standard errors, and the table shows the mean absolute deviation and the standard deviation of the coefficient deviation, for each run. According to standard regression assumptions, the expected values are 0.798 and 1.0 respectively.

The distribution of p, and the moments kl and k2 are readily calculated, since p is the sum of the constant a0, and nine equally weighted binomial variates x1 - x9. The probability that exactly r of these variates have the value 1 and the rest 0 is given by the binomial distribution:

P!r (1-p)! n-r ((n-r)/r)

WHERE n is the number of binomial variates, and

P is the probability that any one has the value 1.

The mean of the distribution is simply nP, and the variance nP(1-P) so that:

$k1 = 9 \times 1/2 \times 0.1 + 0.1 = 0.55$

$k2 - k1(2) = 9 \times 1/2 \times 1/2 \times 0.1 \times 0.1 \times 0.1 = 0.0222$

$R^2 = 0.0222/(0.55 - 0.55(2)) = 0.0898$

This is the asymptotic value of R^2, to which the values in the table tend as sample size increases.

THE STRUCTURAL COMPONENT

The structural error component can now be reintroduced. Each individual value of p is distorted by a random quantity $\mathcal{E}$, which is assumed to have a Normal distribution with a mean 0 and standard deviation @E.

When structural errors are included, the sum of squares about the regression line becomes:

$$\partial E\,(y-p)^2 = \int (1-p)^2\, N(p+\varepsilon)\, f(p)dp + \int p^2 N(1-p-\varepsilon) f(p)dp$$
$$= \int N\, f(p)\,(p+\varepsilon-p^2-2p\varepsilon)dp$$

(integrating from 0 to 1)

Since only linear terms appear in the result, it follows that for moderate values of ∂E the existence of structural error will have no effect on R^2. The proportion of variance explained by the model will be a function of statistical error alone, and will not reflect any structural deficiencies in the analysis.

In the second set of simulations the statistical influence was held constant, and the amount of structural error varied by changing the standard deviation of ε. The prediction that R^2 would remain constant for moderate values of ∂E is borne out by Table 2. The two measures based on a comparison of the fitted coefficients with the original simulation values show a quite systematic deterioration in the model's ability to recover coefficients as structural error increases. However, there is no such systematic effect on R^2, which remains significant at the 95% level on the standard test and is as close to the asymptotic value of 0.0898 when $\partial E = 1$ as it is when $\partial E = 0$. The inevitable conclusion is that low R^2 values are a result of the nature of the dependent variable and do not necessarily indicate any structural weakness in the model.

It is clear from Table 1 that the statistical error component behaves in a similar manner to the error in a standard regression model. The two measures of coefficient recovery remain adequately close to their expected values. However structural error behaves rather differently. Increasing values of ∂E cause a deterioration in the coefficient measures, but without a corresponding change in R^2. The result is that the coefficient measures show a trend to values that are well outside the expected range under standard regression assumptions. In short, the standard error of a regression coefficient can be calculated by the standard methods when statistical error is present, but increasing structural error results in increasing underestimation.

FURTHER ANALYSIS

The analysis thus far has raised two major points. First, the success of the model as expressed in Equation 1 cannot possibly be assessed by means of R^2. Second, measures of the standard error in regression coefficients are biases when structural and statistical error are both present. So consider here that the preceeding analysis is pursued in more formal terms leading to the discussion of steps that can be taken to rectify the two difficulties just cited.

The fundamental problem can be expressed quite succinctly in terms of the ability of the y values to give accurate estimates of the properties of the p values. Taking

TABLE 1

STRUCTURAL ERROR ABSENT ($\partial E = 0$)

Sample Size	R^2	Mean Absolute Error in a	Standard Deviation of Error in a
20	.4832	.943	1.048
50	.2711	.459	.610
100	.1085	.423	.611
200	.0863	1.01	1.216
500	.1236	1.07	1.277

TABLE 2

VARYING STRUCTURAL ERROR

Sample Size (N)	∂E	R^2	Mean Absolute Error in a	Standard Deviation of Error in a
200	0	.0986	.490	.600
200	.1	.1586	.784	.971
200	.5	.0528	.927	1.147
200	1.0	.0831	1.730	2.059

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the mean first, we have:

$$\hat{y} = \int P(y=1|p)\, P(p)dp = \int pP(p)dp = \hat{p}$$

Thus the mean of y is an unbiased estimate of the mean of p.

Now consider the second moment of y.

$$\int P(y=1|p)\, P(p)dp = \hat{p}$$

Thus the second moment of y is not an estimate of the second moment of p. It follows that measures based on the sum of squares of p, such as R^2, the standard error of regression coefficients, or statistical tests of the significance of R^2, will be distorted when y is used as the dependent

variable.

Now the crossproduct of y with an independent variable:

$$\int\int xi\ P(x(i))dx(i)\ P(y=1|p)\ P(p)dp =$$

$$\int\int x(i)\ P(x(i))dx(i)pP(p)dp$$

which is the crossproduct of p and x(i). So the regression coefficient estimates, which are based on the covariances and the variances of the x(i), will be unbiassed.

Stated in these terms, the problems stem from the impossibility of estimating the variance in values of p. When structural error is assumed absent, the variance is simply that of the fitted p values, so no problem arises, but actual p values may be distorted by the unknown component ε.

A NEW MEASURE OF STRUCTURAL ERROR

The only possible means of assessing the amount of structural error in the model is by a comparison of the actual and fitted p values. While the observed y values reflect the actual, but unknown p values, they do so only in a statistical sense. In a complex problem, each individual probably possesses a unique combination of independent variable values, or socioeconomic traits, and thus a unique p value. Thus each y value represents a single trial of a unique experiment. (See the review of this chapter for a different comparison method than the one presented here based on the GLS regression methods described in the Cicchetti and Smith appendix to this volume.)

Suppose that the fitted p values were grouped into ranges, say 0 - 0.1, 0.1 - 0.2, etc. Then in the absence of structural error, the proportion of those individuals whose fitted p values lay in each range should be roughly equal to the central p value of each range. Thus approximately 5% of those individuals with a fitted p value in the first range should be observed to participate in the activity. The precise number will be governed by the binomial distribution so that the probability that precisely r individuals will participate is:

P(r) = p(c)!**r (1-p(c)!**(n-r) ((n-r)/r)

WHERE the central p value is P(c), and

n individuals have p values in the range.

Unfortunately, if we assume that structural error distorts p values in a normal distribution with a mean of 0, then the proportion of individuals will remain roughly the same, irrespective of the amount of structural error present, since upward distortions in p are as likely as downward distortions. However, it is clear that towards the

limits of 0 and 1, the normal distribution is not a reasonable model of structural error, since near 0 upward distortions must be more likely, and conversely near 1. This suggests, then, that the deviations in observed proportions from the central p values in each range, particularly near 0 and 1 may be a reasonable measure of structural error.

These ideas are now clarified with an example. Figure 1 shows the distribution of fitted p values for the simulation run s = 0, N = 200, that is, a sample of 200 generated with no structural error. Figure 2 shows the distribution of numbers of participants by fitted p value, so that each bar represents the number of individuals who participated, and who had fitted p values in that range. Table 3 shows the corresponding proportions.

TABLE 3

FITTED p DISTRIBUTION

Central p	p Value Count	Participant Count	Proportion	Standard Error
.05	1	1	1.0	.22
.15	8	4	.5*	.13
.25	15	0	0	.11
.35	31	13	.42	.09
.45	37	16	.43	.08
.55	42	16	.38	.08
.65	34	28	.82	.08
.75	23	18	.78	.09
.85	8	6	.75	.13
.95	1	1	1.0	.22

* Probability of observing a value at least this different from the central p is less than 5%.

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The reliability of each observed proportion depends on the p value count in that interval. Clearly values toward the middle of the table are based on larger samples and should thus be given greater weight. In view of this, a better strategy might be to organise the distribution into intervals of equal numbers of observations. Table 4 shows the same distribution in the form of the ten deciles, so that each interval contains precisely 20 observations of fitted p values.

The proposed structural error index S(2) is based on

TABLE 4

FITTED p DISTRIBUTION BY DECILES

Central p	p Value Count	Participant Count	Proportion	Std Error
.151	20	8	.40*	.08
.333	20	4	.20	.11
.386	20	5	.25	.11
.431	20	12	.60	.11
.470	20	6	.30	.11
.506	20	11	.55	.11
.553	20	10	.50	.11
.610	20	10	.50	.11
.668	20	16	.80	.11
.802	20	17	.85	.09

* Probability of observing a value at least this different from the central p is less than 5%.

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the fit of observed proportions to central p values, when the data is arranged by deciles, weighted by the expected reliability of each proportion in a modified R^2 statistic:

$$S^2 = 1 - \frac{@E\ (s(i)-x(i))^2/(x(i)-x(i)^2)}{@E\ (s(i)-0.5)^2\ /(x(i)-x(i)^2)}$$

WHERE $s(i)$ is the observed proportion in the ith decile and $x(i)$ is the central p value, and the summations are from 1 to 10.

Table 5 shows the computed values for the index for the conditions used in Table 2. Each experiment was repeated 25 times, and the table shows the observed mean and standard error of S^2.

The index shows the expected trend. The upper limit of the scale, corresponding to $@E = 0$, depends on the sample size and will approach 1 as the sample increases and observed proportions become more accurate estimates of central p values.

SUMMARY

This paper has been concerned with models which relate an individual's socioeconomic characteristics or traits to

TABLE 5

EFFECT OF VARYING ∂E ON S^2 (N = 200)

∂E	Mean S^2	Standard Error
0	.782	.120
.1	.766	.147
.5	.599	.222
1.0	.616	.187
2.0	.271	.310

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the probability of his participating in specific recreation activities. Such models are calibrated by using as the dependent variable a binary representation of the individual's actual behaviour, which is only statistically related to the model probability.

Under these conditions, the R^2 statistic is determined by the statistical relationship between probability and binary event, and in no way reflects the model's actual goodness of fit, or its structural error. Estimates of regression coefficients are unbiassed, but since the binary event variable cannot give an estimate of the variance of the probability variable, R^2 and related statistics are of questionable value.

If each individual must be assumed to have a unique socioeconomic mix, then each event is a trial under a different probability, and measurement of errors in those probabilities is extremely difficult. The method suggested is a measure of the goodness of fit between probabilities and proportions of events when observations are grouped into ranges of probabilities. It is argued that structural error will produce distortions in this fit towards the ends of the probability spectrum at 0 and 1.

Simulations were used to demonstrate the proposed index. They show the expected behaviour under increasing amounts of structural error. Standard errors are quite large, and the expected values of the index depend on sample size, on the form of structural error, and also on the parameters of the model, so that the index should be used only as a relative scale and not as an absolute measure. It would be wise to simulate the expected values of the index under the specific conditions of each application.

Should the model be applied to cases where numbers of individuals have the same socioeconomic characteristics, many of the problems are much less severe. Calibration can be carried out using observed proportions as the dependent variable rather than binary events. The reliability of each

proportion depends on the number of individuals involved, so that the data should be weighted accordingly. The problem has been discussed in the context of recreation flow models in TN No. 19, and many of the conclusions of that paper can be applied to the participation modelling problem.

GEOGRAPHIC DATA PROCESSING CONCEPTS AND THEIR APPLICATION TO PARK AND OTHER LAND USE PLANNING

M. F. Goodchild

ABSTRACT

The issues surrounding the automated processing of geographic data are subtle and complex. This paper examines the field from the particular stance of the land use planner, on the assumption that the major purpose of automated processing in this context is to answer questions of a geographic nature that cannot be readily answered by manual map analysis. In this context study areas are usually small, and study emphasis is more on the ability to provide rapid answers to complex questions than on the banking of large volumes of data.

Issues are reviewed under the general headings of the nature of geographic data, the basic pros and cons of machine processing, the alternatives in data storage, and the issues in the encoding process. The conclusions reached are consistent with the designs of several operating geographic information systems.

The PLUS system developed by the author is used to provide two sets of illustrations in the final sections of the paper. One is of the encoding and verification of a typical geographic source document to produce an accurate data base for a variety of applications. The other shows the PLUS/2 system in operation as it responds to a set of queries about a study area in Southeastern Manitoba from a fifteen-map data base of physical geographical variables.

PREFACE

Early in 1973 the author was asked to prepare a paper for the Department of Indian and Northern Affairs on the then current status of geographic data processing and its potential as a tool for park planning (see Reference 23). That paper identified the major issues and reviewed the various approaches that have been adapted to them. The paper was discussed at a series of meetings with interested representatives of a number of agencies and led (in the summer of 1973) to a contract with the Lands Directorate of Environment Canada for the development of a limited land-use planning system to satisfy a number of objectives. First, the system was to permit the manipulation of maps in a variety of ways in an interactive mode. This sort of facility is impractical in many geographic information

systems but is feasible in a system dedicated solely to land-use planning because the accuracy requirements are less severe. Second, the system was to make the maximum use of existing data banks by providing interfaces to them. (The greatest obstacle to the adoption of geographic data processing has been the problem of data encoding, which requires a large commitment to hardware and staff. Yet this obstacle is slowly being eroded as more data becomes available in agency archives.) Finally, the system was to allow the input of raw data in limited quantities and in the most efficient form possible.

The system became known as PLUS (see Reference 26), organised into two sections, PLUS/1 containing the data bank interfacing and data input, and PLUS/2 the interactive map manipulation. A case study was used to provide test data and to demonstrate the use of the package (see Reference 25). Interfaces were developed with the co-operation of the Canada Geographic Information System (Lands Directorate, 1974) and the Canada Soil Information System (Dumanski and Kloosterman, 1973) and the system has been demonstrated in a variety of contexts (see, for example, Reference 27). Data can be input and output in a variety of other standard forms, allowing direct interfacing with SYMAP, CALFORM and POLYVRT (Harvard University Laboratory for Computer Graphics, 1974) and US Census DIME files (US Bureau of the Census, 1970).

The present paper reviews the concepts and important issues underlying geographic data processing, and provides illustrations and examples drawn from the author's work with PLUS. Development of the system is continuing.

THE NATURE OF GEOGRAPHIC DATA

The principal purpose of this paper is to review the field of geographic data processing in the particular context of land use planning. (For a more general review see Reference 12, 58). It might be as well to begin with an attempt at a definition of the phrase "geographic data", before discussing the problems it presents. Consider the question "How much of the land that lies within five miles of a certain town is under 500 feet above sea level?" If a data base is to be capable of answering such a question, it must contain information on height and on location. It might for example contain the precise locations of contour lines in the area, through the locations of a sequence of points at which the contours change direction. Or, as another alternative, the topography might be represented by accurate heights at every intersection of a very fine grid mesh laid over the area. With either method, an answer could be given through an appropriate series of arithmetic and logical steps.

The two methods mentioned above are often referred to as the polygon and grid systems of data encoding; each is geographic because each contains explicit locational

information. As a counterexample, suppose that the topography had been represented by the average height of land in each Census Enumeration Area on the map. It would then have been impossible to answer the original question without reference to the Enumeration Area locations and boundaries. So a geographic data base can be defined as one possessing explicit geographic information.

The traditional method of storing, displaying and communicating geographic information has of course been the map, a stylised two-dimensional representation of reality. All of the methods currently available for processing and communicating information are one-dimensional, working with a single linear stream of data, and geographic information must be represented in this way if any of the current data processing technologies are to be applied to it. This difference in dimensionality is responsible for a fundamental paradox in all efforts at image or picture processing, pattern recognition, or geographic data processing; since the eye is a two-dimensional processor, it is often as or even more effective than the digital computer in certain kinds of operations. The computer is often only a marginally beneficial processor of geographic data.

Geographic data can be classified in a variety of ways; in a discussion of data processing it is particularly useful to distinguish between point, line and area data. A point representation is often used when a map must show the locations of objects whose size is much less than the intervening distances between the objects. Line representations are used for such phenomena as railways or roads; area representations are used when characteristics are to be ascribed to substantial tracts of land, as on soil maps for example.

Several other rather specialised types of map can be classified as variations on this typology. Contour maps can be seen as (a) area maps on which the contours are area boundaries, or (b) line maps on which heights are to be interpolated between neighbouring lines. Points are sometimes used to infer areas, as when the locations of Census districts are given by centroids.

A map can display several types of information at once, but for data processing purposes it is difficult to deal with more than one. The term 'coverage' is used in the paper to refer to a single type of data and a defined geographic area. So a coverage is a one-dimensional classification of a two-dimensional segment of the earth's surface. An area-map coverage consists of a single partitioning of an area into non-overlapping, homogeneous zones.

The relative importance of each type will of course depend on the context. However, the scale of most land use planning is sufficiently detailed that the bulk of requisite information is areal. Much of the relevant data, on soils, land use, vegetation, etc., is collected directly in areal form. In addition, most socio-economic data is collected by predetermined areal units and is therefore also areal. On

the other hand, topography, climatic variables and water table depths are usually determined by point sampling and represented through contoured maps. Highway rights of way are sufficiently narrow that they can often be dealt with as line data. In summary, while areal data predominates, all of the standard types can be recognised as relevant to land use planning.

Finally, accuracy is an important issue which can easily be overlooked. The paper touches on the question at several points, as the degrees to which the results of data processing reflect the information on the source maps. There are complex payoffs between the costs of processing and the accuracy of the results. Basically, there is no value in providing accuracy in data that will never be used in analysis. Nor is there value in an elaborate system which can provide precise answers if they are based on inaccurate data. An air photo analyst may subjectively draw a line which encloses land of a roughly homogeneous soil type; yet the data processing system will objectively ascribe the precise soil type to precisely all of the land within the line.

The Case for Machine Processing

Geographic data processing is a relatively new field. Although it has been possible to handle geographic data since the earliest days of electronic computers, it is only through the enormous reduction in costs per operation over the last 20 years, and the simultaneous increases in storage capacity, that processing has become economically feasible on a realistic scale. (The points made in this section are discussed in more detail in Goodchild (1973).)

Three types of geographic data manipulation are considered in this section. The advantages of automatic processing are assessed in the context of mapping, then in relation to geographic information retrieval, and finally in the analysis of geographic relationships and model calibration. All three areas are to some degree relevant to present day land use planning, and are assessed in that context. But, as well, it is important to bear in mind that the development of geographic data processing techniques may open new directions for land use planning in the future.

Automated Cartography

Once geographic information has been coded, it can readily be retrieved in graphic form as a computer-produced map (see Reference 48). Two main methods exist, based on the plotter or computer-driven pen, and the line printer. In Canada, both the Canada Land Inventory, through the Canada Geographic Information System (Lands Directorate, 1974) and the Department of Agriculture, with the Canada Soil Information System (Reference 15) have produced massive data files of coded information readily usable for producing plotted maps. Canada Land Inventory coverages are described

in Reference 15. Similar efforts in other areas can be found in the GRDSR program of Statistics Canada (Reference 55), the National Topographic Survey of the Department of Energy, Mines and Resources, and other agencies, both federal and provincial.

In the line printer case, relatively crude maps have usually been made by overprinting symbols to create different shadings (see Figure 4) although more recent variants such as the electrostatic plotter produce more acceptable results by a dense application of small dots.

At the simplest level, automatic cartography is not an efficient way of making a map. It would clearly take at least as long to describe the map to the machine by encoding it as it would to plot it by hand. But there are many sets of circumstances which may justify computerising a map. First, once encoded the map is stored by the computer so that the benefits of encoding extend beyond the cartographic exercise. The data might be used to plot the same map at different scales or to draw only part of it: or The coded map might be used as a source of information in some analytic problem. Second, there are cases in which the same computer-coded base might be used to produce different maps. For example, once the outlines of census areas are coded it is possible to produce innumerable maps of different census variables very cheaply. Furthermore, one may wish to process the map between the coding and drawing stages. It might be necessary to change projection or scale: or computer processing might be used to make corrections and modifications before drawing an updated final copy of a map. And finally, a great deal of work in the printing process (in the preparation of colour separations) can be avoided by effective automation.

But while each of the operations mentioned may be very relevant to the routine production of topographic, soil or census maps by the appropriate agencies, the land use planner is unlikely to justify encoding geographic data for the sole purpose of automated cartography. He is more likely concerned with a unique, limited study of a specific area, with very little likelihood that the data will be useful to other studies in the future, at least without extensive updating and revision.

Information Retrieval

The land use planner must work with answers to a wide variety of geographic questions, ranging from the simple "What is here?" on a single coverage to complex comparisons of several coverages, such as "How much land of types x, y and z on coverages A, B and C lies within N miles of location L?", or problems involving a search over feasible locations to find optimum sites. Some of these questions can be answered by eye, and it is not difficult to construct a case in which the eye can accomplish an operation (evaluation) more rapidly than a third-generation computer, given a clear map and a prior encoding. Even when

information must be collated from several maps, the advantages of machine processing are marginal at best.

Other similar questions fall into the same category, like "Where is the boundary between these two areas?". But a second category of operation can be specified: those that are marginally feasible by hand for which there is a clear advantage in machine processing. Any evaluation of area, however simple, is a cumbersome and tedious operation if done manually by the traditional methods of planimetry or dot counting. It is especially so if qualifications are placed on the evaluation, such as "How much land of type x occurs in blocks of greater than 100 acres?" or "within five miles of town L".

A third category of information-retrieval operations consists of those which are virtually impossible by hand. These are new capabilities provided by machine processing, rather than old capabilities to be compared to manual methods. Included in this category are many of the problems which involve the comparison of two or more coverages, such as "How much land is of type x on coverage A and type y on coverage B?". The preparation of a composite map by the arithmetic or logical combination of two or more simple coverages is of this complexity, or operations of the form "Display all land on coverage A that has value y on coverage B". Again, different types of data might be mixed, as in the problem "How much land of type x on areal map A lies within one mile of a railway right of way on line map B?".

The second and third categories of information-retrieval operations are likely to provide the strongest justification for a geographic information system in the planning field, designed for and as far as possible operated by planners themselves. But this is only one of the possible orientations of a geographic information system; for example, the data-acquisition and cartographic functions of the Canada Land Inventory dictate an entirely different set of criteria for the Canada Geographic Information System. This paper adopts the planning orientation, and should not be interpreted as a review or critique of the entire field of geographic information systems.

Advanced Analytic Capabilities

Computationally, there is no limit to the complexity of operations that can be programmed into a geographic information system. Thus far we have considered three broad categories of data manipulation and information retrieval, but the potential is obviously much greater. But there is a basic dilemma in going much further. Since few of these operations have been available to land use planners in the past, the profession has had to evolve largely without them. So understandably most planners are at a loss to suggest additional capabilities, or even to structure their existing procedures along appropriate lines. The precision and objectivity of data processing are largely foreign to methods that have evolved without mechanical aids. So while

the capabilities described above may fit directly into planning practice, more advanced operations are likely to do so only in the long term.

Consider the following example. A power line is planned across productive agricultural land and must follow the route of minimum cost, defined as the composite of construction cost, land acquisition, transmission cost and agricultural production loss. Potential agricultural production can be calculated from agricultural capability, which is available in map form, but the actual relationship has yet to be established. Advanced geographic data processing capabilities might be used in this context, first to establish the relationship between potential production and land capability (by regressing past yields against the map of capability) and then to select the optimum site by a minimising search algorithm. Whatever the set of operations finally considered useful for land use planning, it is clear that any system must have the potential for rapid and easy addition of new capabilities as the need for them becomes apparent.

THE ISSUES IN MACHINE STORAGE

In discussing the costs and benefits of various approaches to machine storage of geographic data sets, there are three separate sets of criteria to be considered. First, there are alternative methods for actually encoding data, each with its own advantages and disadvantages. Second, long-term storage presents its own problems of efficiency and reliability. And third, there is a wide variety of eventual applications of the data which must be reflected in the methods of storage and retrieval.

The two methods of automated cartography, plotter and printer, correspond precisely to the two major methods of data storage, polygon and grid. Plotter maps are drawn by driving a pen around each of a number of boundaries; polygon data is stored as a sequence of points which, when connected, indicate polygon boundaries. Similarly, printer maps are created by placing a symbol in each of a finite array of cells; correspondingly, grid data is stored as a collection of discrete values associated with grid cells.

Within each of the two classes there are innumerable variants. The record in a polygon data set can consist of all that land classified by a certain code, or a complete contiguous polygon, or a segment of a polygon boundary between two junctions, or a single boundary point. These may usefully be referred to as levels 1, 2, 3 and 4 files respectively. Certain variants contain more than one level. The SYMAP structure is a pure level 2 form, whereas the CALFORM structure combines level 4 and level 2 subfiles. (See Reference 30.)

The grid data structure may vary according to the convention for ordering cells, although the commonest by far is the basic printer sequence, by rows from the top left

corner. More importantly, the structure may be compressed so that extensive runs of the same cell type are replaced by integral multipliers. The literature on data structures is extensive; for reviews see References 00, 00.

The accuracy with which polygon data represents its source document depends on the accuracy with which each boundary line is encoded. If the boundaries are excessively contorted, they may require a high density of points to create an accurate representation, while the largely straight lot lines of a land use map can be coded with a much lower density. But in general a moderate number of boundary points are sufficient to make an adequately accurate polygon data set.

By contrast, a grid data set has a definite and predetermined level of accuracy once the grid cell size is set. Relationships exist between grid cell size and the reliability of any estimate of area, or any other geographic parameter. (See Reference 24, 57.) Yet in spite of the sacrifice of precision, gird data has a very clear advantage in any of the more complex forms of geographic data processing. Maps can be made equally readily from either data type, but any operation which requires the evaluation of land type at a specific location, or the comparison of different maps, is far more readily executed with grid data than with polygon. With grid data, it is a simple matter to calculate the cell in which a point lies, and thus to retrieve its characteristics, but with polygon data it is a substantial problem to associate a specific polygon with a given point.

For this reason most advanced data processing of the type outlined above has been carried out on gridded data sets. The sacrifice of accuracy has been judged to more than compensate for the excessive computational problems of information retrieval from polygon data. Optimally, each coverage is coded by a precisely similar grid, so that the nth cell in the first grid corresponds to the nth in every other.

But while information retrieval and analytic operations are best performed on grid data, there is no need to store all data in that form, as transfer is easy between the two types, particularly from polygon to grid. Grid data sets are only rational once a level of accuracy and a study area have been determined. Thus one finds that the polygon structure has been adopted by most agencies with responsibility for data collection, storage and cartography, while grid data is favoured for sophisticated retrieval and analysis. Ideally, data should be collected and stored in polygon form, and then gridded for each specific study area and level of accuracy. Collecting directly in grid form places too many restrictions on the usefulness of the data, while analysis using polygon data is bound to be inordinately expensive.

THE ISSUES IN DATA ENCODING

The encoding of point or line data presents no particular problems. Co-ordinates can be taken directly from source documents with readily available digitising equipment. Grid coding of areal data is similarly elementary, though unlikely for the reasons discussed in the preceding section. But the encoding of areal data in polygon form has historically been one of the main stumbling blocks of geographic data processing. In the simplest manual system a digitiser operator indicates a sequence of points that he wishes to have encoded, together with the contents of each polygon. There are many variants of the process, depending on the degree to which computer processing is used in the eventual editing. A few possibilities are discussed below.

The SYMAP Method: Complete Polygon Encoding

In this system, the polygon constitutes a file record (a level 2 file according to the above notation). The operator codes a series of points defining each polygon outline in clockwise order, and then codes the contents of each polygon. See Figure 1(a). As a result every boundary is coded twice, as part of the polygon on either side. The two versions of each line will inevitably conflict, so the crude image is often processed to resolve any deviations of less than some allowable amount, say 0.05-inch, to create a clean file.

The CALFORM Method

The file cleaning process mentioned above is potentially dangerous, since any real detail in the map at a scale of less than 0.05-inch will be removed along with the spurious detail. The CALFORM method attempts to resolve this potential ambiguity and to economise in effort by avoiding the double encoding of each line. Every polygon vertex on the map is first numbered and location encoded in a level 4 file. Then the polygons are coded by listing the sequence numbers of their vertices, to create a level 2 file. See Figure 1(b). Although the method becomes unmanageable when large numbers of vertices have to be numbered, it avoids both of the difficulties of the SYMAP system. But a realistic encoding method must be made to deal with thousands of polygons and hundreds of thousands of vertices on a single map.

PC(Segment) Methods

PC methods divide the polygon networks into sections of boundary between junctions (a level 3 file) and so avoid the duplication problem of the level 2 methods. See Figure 1(c). But each junction now creates a problem, since it occurs at the end of each of several records, and may be coded at a slightly different point each time. So a certain amount of

processing must be used to resolve discrepancies to within an allowable limit. A variety of methods have been devised to resolve discrepancies in an unambiguous way. In some cases each junction is encoded in a separate digitising phase; in others, each segment is named according to the polygons it bounds.

PC encoding can become a complex and confusing task for a digitizer operator, who must continually switch between point encoding and the identification of polygons. In some variations of the method, polygons are identified in a separate phase of the encoding process after the entire point encoding is complete. This is easier for the operator, but requires a more sophisticated processing stage to resolve more complex ambiguities at junctions. The IC method implemented in PLUS/1 is one example, see Reference 25. The operator first codes the boundaries by identifying vertices, but without necessarily beginning and ending records at each junction. The polygons are then identified by encoding one point within each one and giving its characteristics. Computer software identifies all junctions, breaks the encoded boundaries at appropriate points, and attaches each polygon type to the segments forming each polygon boundary.

Semi-automatic Methods

The encoding methods described above can be automated in various ways. First, the digitising process can be accelerated if points are coded automatically, at given intervals of time or over given distances, rather than by a conscious act of the operator. Second, a great deal of work has gone into making the line-following process semi-automatic, with a limited amount of operator control to resolve ambiguities. The map is usually scanned by a device similar to a TV camera, moving under the control of a small "dedicated" computer. Ambiguities are brought to the operator's attention when they cannot be resolved internally. (For example, Reference 8.)

Fully Automatic Coding

The technology necessary to read an entire map and place it in computer storage has existed for a long time. Unfortunately, such a vast amount of data is created if the map is scanned with any degree of precision that the cost of sorting out polygons by computer processing is inordinately high. In addition, most source documents must be redrawn prior to scanning to remove any marks that do not represent polygon boundaries, an operation that often occupies as much human effort as manual digitising. But several trends suggest that such systems will enjoy increasing popularity in the future. Computer processing is becoming cheaper, while the cost of manual operations is increasing. And with better software, it should be possible to scan images that are closer to the source document in quality, without requiring expensive redrafting. But at the present time the

PC (Segment) methods discussed above are clearly the most practical and economical for the creation of polygon data sets except in the largest agencies.

Editing Data Sets

These are two fundamental problems in editing or updating areal data sets and they are largely responsible for the difficulties which all practical systems have experienced. First, there are internal consistencies within any polygon data set, so that changes may have to be made at several points in the file at once. For example, if a boundary point location is changed in SYMAP data set, the change must be made to at least two of the coded points in the file. Or if a polygon characteristic is changed in a PC file, it must be changed in all of the records which make up the polygon boundary. So it is essential that editing be done using specialised software so that internal consistency can be preserved.

Secondly, there is a fundamental difficulty in relating the contents of a file to the appearance of a map. The coordinates of a point cannot be associated with particular lines on a map without the aid of a digitiser or plotting device, so both machines are usually considered essential to the editing process. Some editing systems use graphics terminals to display sections of a data set, so that the user can identify the location of errors on the original source document. Errors can then be corrected with the terminal cursor, which the operator can position to revise locations or to indicate changes. This sort of man/machine interaction appears to be the best solution to the editing of polygon data, but suffers at the moment from the smallness of graphics terminal screens. The ideal system would operate at the same scale as the source document, perhaps through a combined digitiser/plotter system with a head that could be driven or positioned manually, in an interactive mode.

EXAMPLES

The Encoding Process for Polygon Data

The first example illustrates the preparation of an areal data set of the polygon type from the source document, using the PLUS software package. The map chosen for encoding is one showing the pattern of Census Enumeration Areas in the city of London, Ontario; there are 478 separate polygons on the map, mostly with simple rectilinear outlines. The map was coded using a simple manual digitiser, with a cross hair cursor connected by a rigid arm and steel cables to two incremental counters. A digitiser operator pressed a foot switch whenever a point was to be encoded, causing the point's x and y co-ordinates to be recorded on a punched card, to the nearest 1/100-inch. The overall accuracy,

expressed as the ability of the operator to find and encode the same point at infrequent intervals, is about 0.05-inch.

The IC method discussed briefly above was used to encode the map. In the first stage the operator coded the entire image as a network of lines, breaking the sequence whenever necessary to move to another section of image. Figure 1(d) shows a typical sequence and should help to clarify the method. In a second stage, a single point is located arbitrarily in each polygon, in this case its Enumeration Area identification number. This primary coding operation occupied the digitiser operator for ten hours, in which time roughly 10,000 image boundary points were coded, and 500 identifiers.

As a first step in correcting the errors in this raw data, the image and centres were plotted out at the same scale as the source document (Figure 2). Several kinds of error can be detected immediately, such as those which result when the operator fails to properly indicate a break in the encoding of the image, or when sections of image or centres are omitted. Another two hours were spent in modifying the data to remove such errors.

The data were then processed by a PLUS/1 programme package (POLYSORT) designed to identify junctions, make appropriate breaks in the line image, and attach the polygon identification to the appropriate side of each PC record. At the same time, any gaps at junctions caused by an undershoot or overshoot during digitising were removed to within a certain tolerance (0.1-inch). Nevertheless, errors could still exist in the file at this stage. Junctions could fail to close within the prescribed tolerance, or there could be problems that were not visually obvious at the earlier error correction. More seriously, the use of an error tolerance means that it is difficult to resolve real detail at scales approaching that tolerance without ambiguity.

Three checks for potential errors were made at this stage, besides those already described. First, the internal consistency of the file was checked by linking together all of the PC's forming each polygon boundary, to ensure that no gaps existed and that each was coded with the correct polygon identification. Any errors were flagged by the PLUS/1 program (EDITONE) so that they could be checked and corrected. As a second check, each polygon identification was verified from the original map. Any changes must maintain the internal consistency of the file and so must be made by an appropriate program package (EDITTWO). Finally, the PC file was plotted at the scale of the source document to ensure that the boundary locations were correct (Figure 3).

A clean polygon data set can be used in a variety of ways. The coded map can be gridded at any scale, with any size of grid cell (GRID). See Figure 4. It can be used to calculate areas, perimeter lengths, centroid locations and other geographic summaries (RPG); it can form the basis for mapping using one of the standard polygon mapping packages (SYMAP or CALFORM) and if necessary the data structure can

be modified to any variant of the polygon form (STRUCT); and polygon maps can be overlain (OVER) to produce composites in which each combination of polygons becomes a new, unique figure. (GRID, RPG, STRUCT and OVER are PLUS/1 routines described in Reference 27.)

Information Retrieval with Grid Data

The second example demonstrates the use of geographic data in an information system using PLUS/2. Under this system, answers to a variety of queries are available at a user's terminal (a teletype or cathode ray tube device) in response to simple commands. In the following pages results of an actual run are photographed from a screen in precisely the way a user would see it, with underscoring applied to everything that would be typed by the user. The actual case is taken from a study of the Roseau River basin in southern Manitoba (Reference 27). Data on the area has been gridded, based on 168 columns and 36 rows, so that each map cell corresponds to one quarter section of land. Fifteen coverages of the area were stored in this grid form. The "resource value" recorded for each cell on each map coverage is the predominant value of the appropriate variable in the area covered by that cell.

A computerized "planning" session begins (Figure 5) by the user asking for assistance. The list of commands available in PLUS/2 contains several routines for the analysis of map data, for the preparation of summaries, display of maps, creation of new maps and the combination of existing coverages. The command 'COVERAGES' produces a list of maps in the system; these names, along with the size of grid area and other basic information on the study area are passed from session to session: they can also be entered by a dialogue initiated by the 'RESTART' command.

Incidentally the PLUS.2 system recognises four kinds of coverage, Alpha, Numeric, Lines and Points. Alpha and Numeric maps both consist of cellular arrays, but differ in the allowed list of operations. The values on a Numeric map are assumed to be measurements on some scale, whereas no interval or ordinal relationship is assumed between the alphabetic or numeric symbols on an Alpha map.

After finding out what converages are available the user might ask for a display of one of the maps in the system. 'AGD' is, in reality, the primary agricultural capability class, on a scale of 1 to 7. Because only 72 print positions are available on the terminal being used, the system asks for a part of the map to be specified. It has previously determined that the map must be displayed as six 'pages', two rows and three columns, so that page 1,2 corresponds to the top centre of the map. Page 1,1 is the top left, and page 2,3 the bottom right. (See Figure 6.)

These maps are crude images that can be produced at the terminal in seconds. More permanent maps of published quality might be produced from the same data by directing output to a line printer. A command 'PILOT' is available in

PLUS/2 when permitted by the specific computer system in use.

What Proportion of Land is Class 2?

In displaying a map, the system is merely making a crude reproduction of a source document. But the same data can be used to answer a series of questions. Consider first a question which can be answered through the 'TABULATE' command. Since the AGD file being considered is Alpha, the values on the map are reported in the order in which they are found, and in the actual request, the output shows that 12.3% of the area Class 2, a total of 742 cells (Figure 7).

How Much Land is Class 2 With an Average Water Table Depth of 12-30 Inches?

The coverage 'SLG' contains a classification of the depth to water table, using the number 3 to indicate depths in the range 12-30 inches. So the question above requires a comparison of two maps and an evaluation of the area over which two classes coincide. The PLUS/2 'CROSSTAB' command will tabulate all coincidences between two coverages; it shows that of the 742 cells of Class 2 agricultural capability, 126 have the required class of water table depth (Figure 7). This corresponds to a total area of 31.5 square miles.

How Much Class 2 Land Lies Within 10 Miles of Stuartburn?

This query can be answered with the 'DTAB' command, which analyses a map according to distance from a fixed point. The location of Stuartburn is given in terms of the network of cells, as row 18, column 50. The user now indicates how the map is to be analysed. Each cell in the map will be identified in two ways, according to its type, and to its distance from Stuartburn. The user defines ranges of distance, by indicating the upper limit of each range, and the symbol the range is to be given in the output table. Distances must be given in terms of cells, bearing in mind that each quarter-section cell is one half mile across. By specifying limits of 20 and 200 cells, the user is in effect indicating ranges of less than and greater than 10 miles, since no distances of greater than 200 cells occur on the map. From the output, Figure 7, the user infers that only 9 cells have the required characteristic, the majority of Class 2 land lying outside the ten mile radius.

Figure 1

Illustration of Alternative Digitizing Methods

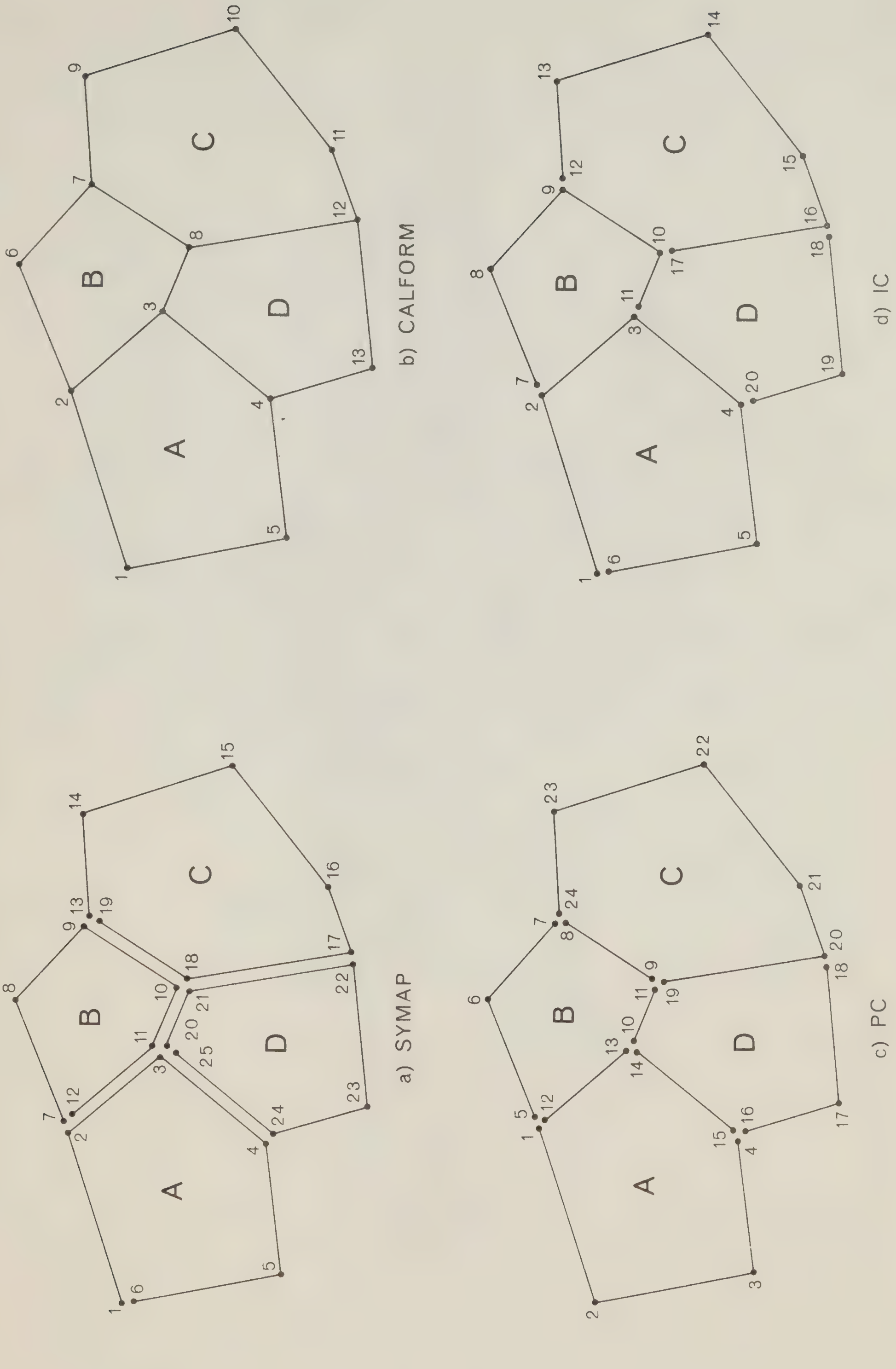

Figure 2
Initial Plot of Example 1

Figure 3
Final Plot of Example 1

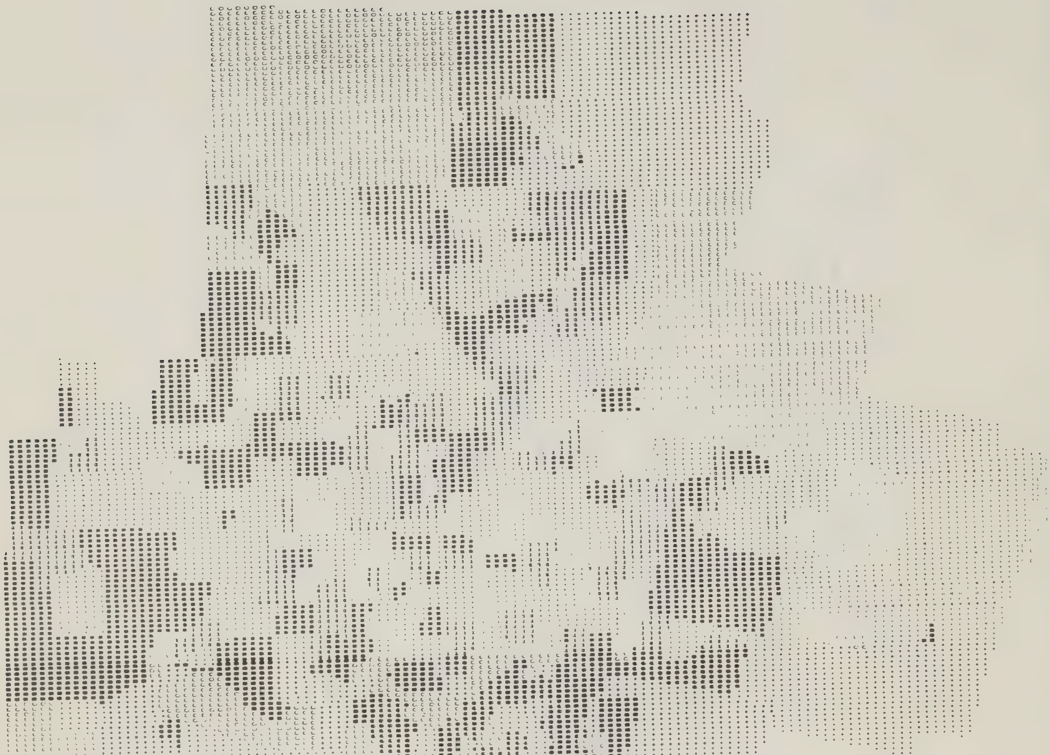

Figure 4
Example 1 as a Grid Data Set

FIGURE 5

```
*****************************************************************
*                                                               *
*       PLUS/2 BASIC VERSION           (12 JUNE 74)             *
*                                                               *
*****************************************************************

FOR HELP USE HELP COMMAND

COMMAND ?HELP
RECOGNISED COMMANDS ARE AS FOLLOWS
                       COMBINE
                       CONTIG
                       COVERAGES
                       CREATE
                       CROSSTAB
                       DISPLAY
                       DTAB
                       DELETE
                       LINES
                       OVERLAY
                       RECODE
                       REGRESS
                       RESTART
                       RETYPE
                       POLYGON
                       STOP
                       STRIPS
                       TABULATE
                       HELP



COMMAND ?COVERAGES
COVERAGES IN THE SYSTEM
NUMBER         NAME            TYPE
 1             AGD             ALPHA
 2             FGD             ALPHA
 3             REC             ALPHA
 4             S16             ALPHA
 5             S26             ALPHA
 6             S01             ALPHA
 7             S02             ALPHA
 8             S03             ALPHA
 9             S04             ALPHA
10             S05             ALPHA
11             S06             ALPHA
12             S07             ALPHA
13             S08             ALPHA
14             S09             ALPHA
15             S10             ALPHA
16             ONE             ALPHA
```

FIGURE 6

```
NEW PAGE - YES OR NO ?YES
ENTER ROW AND COLUMN FOR DISPLAY PAGE ?2,3

 13  440000666600000000000000000000000000000000000000000000000000
 14  444606666600000000000000000000000000000000000000000000000000
 15  444666666600000000000000000000000000000000000000000000000000
 16  446666666600000000000000000000000000000000000000000000000000
 17  456666666500000000000000000000000000000000000000000000000000
 18  566666665500000000000000000000000000000000000000000000000000
 19  566666655500000000000000000000000000000000000000000000000000
 20  566666554400000000000000000000000000000000000000000000000000
 21  666665554400000000000000000000000000000000000000000000000000
 22  666665544400000000000000000000000000000000000000000000000000
 23  566665544400000000000000000000000000000000000000000000000000
 24  666666544400000000000000000000000000000000000000000000000000
 25  666666444400000000000000000000000000000000000000000000000000
 26  060444555500000000000000000000000000000000000000000000000000
 27  000000005500000000000000000000000000000000000000000000000000
 28  000000000000000000000000000000000000000000000000000000000000
 29  000000660000000000000000000000000000000000000000000000000000
 30  000006600000000000000000000000000000000000000000000000000000
 31  000066606200000000000000000000000000000000000000000000000000
 32  000066666200000000000000000000000000000000000000000000000000
 33  000066622200000000000000000000000000000000000000000000000000
 34  000006620000000000000000000000000000000000000000000000000000
 35  000000002400000000000000000000000000000000000000000000000000
 36  000000224400000000000000000000000000000000000000000000000000
       113  118  123  128  133  138  143  148  153  158  163
 168
NEW PAGE - YES OR NO ?NO
```

FIGURE 7

```
COMMAND ?TABULATE
NAME OF FILE TO BE TABULATED ?AGD
FILE TYPE ALPHA
TABULATING FILE TYPE ALPHA
LEVEL            NAME            TOTAL CELLS     PERCENT
 1               2                  742            12.2685
 2               3                  596            9.8545
 3               5                  1158           19.1468
 4               4                  587            9.70569
 5               0                  2609           43.1382
 6               6                  356            5.88624

COMMAND ?CROSSTAB


NAME OF FIRST FILE IN CROSSTAB ?AGD
FILE TYPE ALPHA
NAME OF SECOND FILE ?S1G
FILE TYPE ALPHA
CROSSTABULATION - AGD IN ROWSS1G IN COLUMNS
      3               4      5      1      2
2       215    74    67     372    8      6      742
3       106    126   162    197    1      4      596
5       262    227   48     500    3      118    1158
4       104    173   74     213    3      20     587
0       603    586   377    222    0      821    2609
6       61     83    98     28     0      86     356

        1351   1269  826    1532   15     1055   6048


CHISQUARE STATISTIC 1668.75 WITH 25 DF




COMMAND ?DTAB


NAME OF FILE FOR DISTANCE TABULATION ?AGD
FILE TYPE ALPHA
DISTANCES ARE IN GEOGRAPHIC UNITS. NUMBER OF RANGES ?2
SPECIFY THE UPPER LIMITS OF EACH RANGE, THEN THE
NEW SYMBOL OF VALUE FOR EACH RANGE
LIMIT AND SYMBOL OF RANGE 0  ?20,<10
LIMIT AND SYMBOL OF RANGE 1  ?200,>10
ENTER ORIGIN POINT AS ROW AND COLUMN NUMBER ?18,50
CROSSTABULATION - DISTANCES IN COLUMNS, COVERAGE IN ROWS
                <10   >10
2                9     733   742
3                142   454   596
5                483   675   1158
4                402   185   587
0                156   2453   2609
6                10    346   356
              1202  4846
```

FIGURE 8

```
COMMAND ?RETYPE
NAME OF FILE TO RETYPE ?AGD
FILE TYPE ALPHA
NAME OF THE NEW FILE ?NAG
FILE COMPLETE


COMMAND ?COVERAGES
COVERAGES IN THE SYSTEM
NUMBER          NAME            TYPE
 1              AGD             ALPHA
 2              FGD             ALPHA
 3              REC             ALPHA
 4              S1G             ALPHA
 5              S2G             ALPHA
 6              S01             ALPHA
 7              S02             ALPHA
 8              S03             ALPHA
 9              S04             ALPHA
 10             S05             ALPHA
 11             S06             ALPHA
 12             S07             ALPHA
 13             S08             ALPHA
 14             S09             ALPHA
 15             S10             ALPHA
 16             ONE             ALPHA
 17             NAG             NUMERIC
```

FIGURE 9

```
COMMAND ?RETYPE
NAME OF FILE TO RETYPE ?S16
FILE TYPE ALPHA
NAME OF THE NEW FILE ?NS1
FILE COMPLETE

COMMAND ?REGRESS


NAME OF THE X VARIABLE ?    NAG
FILE TYPE NUMERIC
NAME OF THE Y VARIABLE ?NS1
FILE TYPE NUMERIC
ENTER MISSING DATA CODES FOR X AND Y ?0,0
REGRESSION EQUATION     Y    =  4.57284   +  -0.143034  X
CORRELATION 0.183094  R SQUARED 3.35233E-2
T STATISTIC FOR TEST OF R 9.77371
WITH 2754 DF
X SUM  10695 MEAN 3.88062
Y SUM 11073 MEAN 4.01778
SUM X SQ 46629 VARIANCE 1.85984 DEVIATION 1.36376
SUM Y SQ 47617 VARIANCE 1.13503 DEVIATION 1.06538
SUM XY 42237
NUMBER OF POINTS 2756




COMMAND ?COMBINE


NAME OF THE FIRST FILE IN COMBINATION ?NAG
FILE TYPE NUMERIC
NAME OF THE SECOND FILE ?NS1
FILE TYPE NUMERIC
WHAT IS THE NEW FILE TYPE TO BE ?NUMERIC
NAME OF THE FINAL FILE ?NCO
OPENING FILE IN POSITION 19
OPTIONS FOR FILE NAG
ENTER THE ADDED CONSTANT ?3
ENTER THE WEIGHT ?.5
ENTER THE POWER ?1
ENTER THE NUMBER OF RANGES FOR A RECODE - ELSE ZERO ?0
OPTIONS FOR FILE NS1
ADDED CONSTANT ?0
WEIGHT ?.4
POWER ?1
RANGES ?0
COMBINE OPTIONS - ENTER 1 FOR ADD, 2 FOR MULTIPLY, 3 FOR MAX
FILE CREATED
```

FIGURE 10

```
COMMAND ?DISPLAY
NAME OF FILE FOR DISPLAY ?NCJ
FILE TYPE NUMERIC
ENTER ROW AND COLUMN FOR DISPLAY PAGE ?1,1
HOW MANY RANGES IN NUMERIC DISPLAY ?2
SPECIFY THE UPPER LIMITS OF EACH RANGE ORDERED FROM LOW TO HIGH
LIMIT FOR RANGE 1  ?1.0
LIMIT FOR RANGE 2  ?2.0



 1   111111111111111111111111111111111111111111111111111112221112
 2   111111111111111111111111111111111111111111111112111111221111
 3   111111111111111111111111111111111111111111111111111112111111
 4   111111111111111111111111111111111211111111111112111111112211
 5   111111111111111111111111111111111211111111111112211111111111
 6   111111111111111111111111111111111112111111111111211111111111
 7   111111111111111111111111111111111112211111111111211111111111
 8   111111111111111111111111111111111112221111111121111111111111
 9   111111111111111111111111111111111111111111222111211111111111
10   111111111111111111111111111111111111111111112111121111111111
11   111111111111111111111111111111111111111112111111122111111111
12   111111111111111111111111111111111122111111111111111111111111
13   111111111111111111111111111111111111111111111121221122221112
14   111111111111111111111111111111111111112211111111222222222222
15   111111111111111111111111111111111111111211111111222212122222
16   111111111111111111111111111111111111111122111111122221112222
17   111111111111111111111111111111111111111111111111112221122221
18   111111111111111111111111111111111111111111111211111221112121
19   111111111111111111111111111111111111111111111211111111112222
20   111111111111111111111111111111111111111111112221111111112111
21   111111111111111111111111111111111111111111111121111111112111
22   111111111111111111111111111111111111111111111111111111112221
23   111111111111111111111111111111111111121111111212111111111211
24   111111111111111111111111111111111111211111111121212211111221
         5    10   15   20   25   30   35   40   45   50   55   60
NEW PAGE - YES OR NO ?NO

COMMAND ?POLYGON


POLYGON ROUTINE
WHAT IS THE NEW FILE TYPE TO BE ?ALPHA
NAME OF THE NEW FILE ?FRA
OPENING FILE IN POSITION 20
SYMBOL OF VALUE FOR THE POLYGON INTERIOR ?E
NOW ENTER THE NUMBER OF POINTS FOR THE OUTLINE ?4
ENTER THE COORDINATES OF EACH POINT IN CLOCKWISE ORDER
AS COLUMN NUMBER AND THEN ROW NUMBER
POINT 1
 ?1,1
POINT 2
 ?48,1
POINT 3
 ?48,36
POINT 4
 ?1,36
FILE COMPLETE
```

FIGURE 11

```
COMMAND ?CROSSTAB

NAME OF FIRST FILE IN CROSSTAB ?AGD
FILE TYPE ALPHA
NAME OF SECOND FILE ?FRA
FILE TYPE ALPHA
CROSSTABULATION - AGD IN ROWSFRA IN COLUMNS
       0      F
2        71     671                                        742
3        47     549                                        596
5        1029   129                                        1158
4        291    296                                        587
0        2609   0                                          2609
6        356    0                                          356

         4403   1645   6048

CHISQUARE STATISTIC 4185.14 WITH 5 DF


COMMAND ?COVERAGES
COVERAGES IN THE SYSTEM
NUMBER          NAME           TYPE
 1              AGD            ALPHA
 2              FGD            ALPHA
 3              REC            ALPHA
 4              S1G            ALPHA
 5              S2G            ALPHA
 6              S01            ALPHA
 7              S02            ALPHA
 8              S03            ALPHA
 9              S04            ALPHA
 10             S05            ALPHA
 11             S06            ALPHA
 12             S07            ALPHA
 13             S08            ALPHA
 14             S09            ALPHA
 15             S10            ALPHA
 16             ONE            ALPHA
 17             MAG            NUMERIC
 18             MS1            NUMERIC
 19             MCO            NUMERIC
 20             FRA            ALPHA
 21             ACO            ALPHA
```

FIGURE 12

```
COMMAND ?CONTIG

NAME OF COVERAGE FOR CONTIGUITY TABULATION ?FGD
FILE TYPE ALPHA
ENTER TYPE OF INTEREST, ELSE BLANK ?_
ENTER MINIMUM AREA IN GEOGRAPHIC UNITS ?0
SYMBOL 7 AREA 1
SYMBOL 4 AREA 17
SYMBOL 6 AREA 1
SYMBOL 4 AREA 33
SYMBOL 4 AREA 1
SYMBOL 4 AREA 1
SYMBOL 6 AREA 14
SYMBOL 7 AREA 9
SYMBOL 4 AREA 33
SYMBOL 6 AREA 61
SYMBOL 7 AREA 202
SYMBOL 4 AREA 40
SYMBOL 4 AREA 76
SYMBOL 6 AREA 49
SYMBOL 7 AREA 91
SYMBOL 5 AREA 32
SYMBOL 7 AREA 4
SYMBOL 6 AREA 22
SYMBOL 5 AREA 389
SYMBOL 7 AREA 145
SYMBOL 4 AREA 31
SYMBOL   AREA 4338
SYMBOL 7 AREA 66
SYMBOL 4 AREA 93
SYMBOL 6 AREA 47
SYMBOL 6 AREA 26
SYMBOL 4 AREA 221
SYMBOL 6 AREA 5
```

FIGURE 13

```
COMMAND ?LINES

LINE FILE CREATION ROUTINE
WHAT IS THE NEW FILE TYPE TO BE ?LINES
NAME OF THE NEW FILE ?COR
OPENING FILE IN POSITION 16
INPUT POINTS AS CONTINUOUS STRINGS, FIRST COLUMN THEN
ROW NUMBER. TO END A STRING ENTER 999,0. TO END ALL STRINGS
ENTER 888,0
STRING 1  POINT 1  ?12,36
STRING 1  POINT 2  ?30,28
STRING 1  POINT 3  ?48,28
STRING 1  POINT 4  ?999,0
STRING 2  POINT 1  ?888,0
FILE COMPLETE
TYPE YES TO ENTER STRIPS ROUTINE, ELSE NO ?YES
STRIP CREATION ROUTINE
WHAT IS THE NEW FILE TYPE TO BE ?ALPHA
NAME OF THE NEW FILE ?STR
OPENING FILE IN POSITION 19
NAME OF THE LINES FILE ?COR
FILE TYPE LINES
HOW WIDE IS THE STRIP ON EACH SIDE OF THE LINE ?5
ENTER THE IDENTIFIER FOR THE STRIP ?S
```

FIGURE 14

```
COMMAND ?DISPLAY
NAME OF FILE FOR DISPLAY ?STR
FILE TYPE ALPHA
ENTER ROW AND COLUMN FOR DISPLAY PAGE ?2,1

 13  000000000000000000000000000000000000000000000000000000000000
 14  000000000000000000000000000000000000000000000000000000000000
 15  000000000000000000000000000000000000000000000000000000000000
 16  000000000000000000000000000000000000000000000000000000000000
 17  000000000000000000000000000000000000000000000000000000000000
 18  000000000000000000000000000000000000000000000000000000000000
 19  000000000000000000000000000000000000000000000000000000000000
 20  000000000000000000000000000000000000000000000000000000000000
 21  000000000000000000000000000000000000000000000000000000000000
 22  000000000000000000000000000000000000000000000000000000000000
 23  000000000000000000000000000000SSSSSSSSSSSSSSSSSSS00000000000
 24  00000000000000000000000000SSSSSSSSSSSSSSSSSSSSSSSS0000000000
 25  000000000000000000000000SSSSSSSSSSSSSSSSSSSSSSSSSSS000000000
 26  0000000000000000000000SSSSSSSSSSSSSSSSSSSSSSSSSSSSSS00000000
 27  0000000000000000000SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS0000000
 28  00000000000000000SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS000000
 29  000000000000000SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS0000000
 30  0000000000000SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS00000000
 31  0000000000SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS000000000
 32  000000000SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS0000000000
 33  000000000SSSSSSSSSSSSSSSSSSSSSS00000000000000000000000000000
 34  00000000SSSSSSSSSSSSSSSSSSSS00000000000000000000000000000000
 35  00000000SSSSSSSSSSSSSSSSSS0000000000000000000000000000000000
 36  00000000SSSSSSSSSSSSSSSSS00000000000000000000000000000000000
         5    10   15   20   25   30   35   40   45   50   55   60
NEW PAGE - YES OR NO ?NO

COMMAND ?CROSSTAB


NAME OF FIRST FILE IN CROSSTAB ?STR
FILE TYPE ALPHA
NAME OF SECOND FILE ?AGD
FILE TYPE ALPHA
CROSSTABULATION - STR IN ROWSAGD IN COLUMNS
       2      3      5      4      0      6
0       742    590    939    438    2588   344   5641
S       0      6      219    149    21      12   407

        742    596    1158   587    2609   356    6048


CHISQUARE STATISTIC 836.166 WITH 5 DF
```

FIGURE 15

```
COMMAND ?COVERAGES
COVERAGES IN THE SYSTEM
NUMBER          NAME            TYPE
  1             AGD             ALPHA
  2             FGD             ALPHA
  3             REC             ALPHA
  4             S1G             ALPHA
  5             S2G             ALPHA
  6             S01             ALPHA
  7             S02             ALPHA
  8             S03             ALPHA
  9             S04             ALPHA
 10             S05             ALPHA
 11             S06             ALPHA
 12             S07             ALPHA
 13             S08             ALPHA
 14             S09             ALPHA
 15             S10             ALPHA
 16             COR             LINES
 17             MAG             NUMERIC
 18             NS1             NUMERIC
 19             STR             ALPHA
 20             FRA             ALPHA
 21             ACO             ALPHA

COMMAND ?STOP
GIS SYSTEM CLOSEDOWN - RETAIN ALL DISK FILES
```

Can Agricultural Capability Be Predicted From Water Table Depth?

Neither 'AGD' nor 'SlG' were initially declared as Numeric files, although both contain exclusively numeric symbols, which in turn represent values on crude scales of capability and depth respectively. So they both satisfy the requirements of Numeric files, and their types are changed using the 'RETYPE' command to form files 'NAG' and 'NSl'. The 'REGRESS' command can now be used to test for a predictive relationship (Figure 9). Any cells containing the code '0' in either file are omitted, since the code denotes missing data, leaving 2,756 cases to be evaluated by linear regression. The correlation of 0.183 indicates that a very weak relationship is present, with good capability (low values) corresponding to shallow water tables, but that many other factors also affect the capability index.

Yield Prediction

Suppose that past analyses have indicated that hay yields, in thousands of pounds per acre, can be predicted from the equation

Yield = 3 + 0.5 + 0.4 SlG

The 'COMBINE' function can be used to produce a new coverage in which each cell shows the combined yield prediction from the capability and water depth coverages. The options in the command allow a wide variety of algebraic and logical combinations. See Figure 9.

How Much Class 2 Land Lies in the Municipal District of Franklin?

The outline of the District is used to make a coverage 'FRA' showing the critical area with the symbol F and the rest of the map as O, by invoking the 'POLYGON' command. A crosstabulation of 'FRA' with 'AGD' then shows that 671 cells have the required capability class. This and other new coverages created during the session now appear in the 'COVERAGES' list with appropriate types. (See Figure 11.)

What is the Largest Continuous Block Of Class 4 Forestry Land?

The tabulations above have paid no attention to continguity, so that a total of 100 cells may exist as a continuous tract, or as 100 small fragments. The system can produce summaries of contiguous areas through the 'CONTIG' command. An analysis of the map of forestry capability, 'FGD', shows that 221 cells, or 54.25 square miles are available in one unit. (See Figure 12.)

How Much Class 2 Land

Lies Within 2.5 Miles of the CNR Right of Way?

This is answered in three steps. First, the location of the right of way is supplied to the system through the 'LINES' command, by giving the locations of points at which the lines in the network change direction. Then the 'STRIPS' command creates a coverage based on the Lines file by distinguishing the cells within a critical distance of the network by a particular symbol. Finally, a crosstabulation of this new coverage with 'AGD' shows that there is no Class 2 land within the critical strip. (See Figure 14.)

CONCLUSION AND SUMMARY

The second example illustrated the use of a geographic information system to answer a set of queries that would be largely impossible by the manual analysis of mapped information. The kind of system exemplified by PLUS/2 is capable of providing answers to complex questions both rapidly and cheaply, using data stored in grid form. While it is possible in principle to perform the same operations on polygon data, the computer processing times and costs are much greater and far outweigh the corresponding increase in accuracy. Furthermore, it is doubtful if a user could cope with the volume of data produced in an analysis of polygon data sets. The size of a grid cell in a grid analysis can be adjusted to provide the level of resolution and generalisation appropriate to a particular study, whereas polygon data is constrained to a constant, high level of precision.

The major expense of the system described here, and for that matter of all information systems, lies in the collection preparation and maintenance of the data base. This paper has been written from the planning point of view, on the assumption that the agency using such a system has no explicit responsibility for the acquisition of any particular kind of data, but rather is concerned with making the best use of geographic data sets maintained by other agencies, such as Statistics Canada or the Canada Land Inventory. As such, the final objective of the system must be the ability to respond to queries such as those in the second example; data storage and cartography are not likely to be major objectives by comparison. The selection of data structures is thus dictated by the need for grid form of levels of accuracy can be decided in advance. But more freguently a planning study will require various levels of accuracy as it moves from general studies of an area to detailed examination of critical zones. In such cases it is appropriate that data be first encoded in polygon form, and then overlaid with various grid cell schemes as necessary.

These arguments can be summarised in a scenario for a typical study. The area to be studied is first delineated, and enquiries made to determine the amount of data already available in various agency data banks. Such data is likely to be of polygon form, since agencies with a responsibility

for acquiring data will usually avoid any loss of resolution in the encoding process. Additional data will be needed, besides that available in data banks, and must be encoded from maps. To avoid a premature choice of a level of resolution, such data is best encoded in polygon form, the precise method depending on the equipment available, following the arguments made earlier in the paper.

An initial level of resolution is now determined, and all available data gridded at that level to form a data base for analysis. If the accuracy must be changed later to permit a detailed analysis of part of the study area, the polygon data sets can be regridded with no difficulty. Initially, more information will be needed as the study progresses and should be acquired in grid form if needed for one level of resolution, or on polygon form if required more generally.

Several current trends in the computer hardware industry are likely to affect the area of geographic information systems in the near future, in some cases by altering these conclusions, in others by reinforcing them. First, the cost per operation is likely to continue to drop, along with the cost per unit of central memory. The effect will be to improve the feasibility of automatic polygon data. This should encourage the maintenance of large polygon data sets, which will relieve planning agencies of much of the responsibility for data collection for planning studies. Secondly, the introduction of new forms of solid state circuitry at vastly lower cost and smaller size is leading to the introduction of parallel-processing systems, which can perform many similar operations simultaneously. This trend is of particular importance to geographic problems, in which large arrays must be processed with highly repetitive operations. Finally, although geographic arrays are large, processing is basically sequential in many operations, such as those performed by PLUS/2. Many of the features of large computer systems (such as extensive core memory and direct access disk) tend to be unnecessary, and indeed PLUS/2 can be operated efficiently in a small mini-computer system with a fast central processor and a sequential access disk but very little core.

This paper has identified the major issues in geographic data encoding and processing from the viewpoint of applications in the planning field. Geographic data processing is now entering a rather lengthy phase of demonstration and application. Planners, not computer technicians, must be made more aware of the possibilities it offers, through more efficient responses to geographic questions and through the new kinds of geographic analysis that it permits.

REVIEW

J. Beaman

In the following, one will find no explicit comments on either TN 15 or TN 42. As indicated in the Introduction, TN 15 is provided only as an example of the application of methodology. TN 42 is a combination of general statements about a particular system: it does not pursue the matter of how a system should be developed, rather it presents some alternatives. For these reasons there is really no basis for constructive critique or other review. However, the reader who wants some value judgments about developing geographic information processing systems will find these elsewhere in this Volume, where there are some quite pointed statements about the value of using geographic information processing systems. The reader may wish to refer to TN 27 and the review remarks on it.

From a global and negative perspective, it is not unfair to suggest that TN 24 does not fill a large gap in the CORD Study analysis. The note offers too little accuracy assessment. This is true in terms of the scope of activities covered and in terms of depth of analysis to give the reader any kind of good feeling for the general accuracy of the CORD Study National Survey data and the problems with these data. This is not a critique of the author but rather of the CORD Study itself and a critique that applies to many (actually most) other studies of peoples' participation in activities. Fantastic amounts of money are spent every year collecting information about which there exist major doubts either about the reliability of the information gathered or its validity. And when it comes to the matter of reliability and validity, one touches on one of the strong points of TN 24.

There are many researchers who are thrust into a research role even though their training may be in planning or other fields. These people, as well as some researchers who should know better, either show no concern with accuracy of information that is collected or, particulaly in the case of statisticians, carry out some kind of accuracy analysis on the basis of a split sample, which gives estimates of reliability but which does not confront the basic issue - the reliability of the information collected. One example serves to show the kinds of concerns that should have been dealt with with respect to all activities on which participation data were collected in the CORD Study. When one uses the 1972 CORD Study data on numbers of trips to particular sites to estimate actual 1972 use, one gets two to four times as much use as there actually was. The dramatic way in which this illustrates the deficiencies with the CORD Study National Survey data removes any need for

further comment on TN 24. The example shows both the lack of reliability and lack of validity of CORD Study data is made abundantly clear. The magnitude of errors (related possibly to poor questionnaire designs, possibly to poor interviewing or to something else) has resulted in peoples' responses to questions having almost no relation to reality.

To a researcher with a theoretical or mathematical orientation TN 38 has to be a rather fascinating technical note, although the reader who looks for elegance in such treatment is probably rather disappointed in that a number of issues seem to be left hanging, for example:

(1) Why should one use the linear exponential distance function in such an analysis?

(2) Why not start by introducing all the price terms that are ultimately going to be considered so that the results to be presented can be derived in a 1, 2, 3 fashion?

(3) What are some of the "other" problems with the formulation alluded to other than the condition that suggests that an increase of price per visit of 10 cents results in the same change in use whether the current charge is $10.00 or 10 cents?

(4) What problems with other methods of estimating consumer surplus, etc. does this method overcomes and are there reasons to suggest that this approach gives better results than such methods or does it merely hide problems in a different mathematical way than some they are hidden by different approaches?

Still other matters can be cited as showing areas that the paper did not explore and which would have been desirable to explore, but in all fairness the objective of the paper was to deal with one problem. A single paper cannot deal with all matters related to a new methodology nor can the author of the paper be expected to enumerate all the issues that arise. So this paper is in some ways problematic in the way in which earlier papers on estimating demand function have been.

The points raised above are presented because this reviewer feels that the method proposed in TN 38 should be used intelligently. Also, he feels that there are many areas of research opened up by TN 38 which cry for further exploration and that these areas should not be ignored because of disputes among experts about the merits of the consumers surplus concept or because some economists say certain approaches to certain problems should not be used. In fact, in a political situation, choices must be made based on the approach that the opposition will use. Therefore, in resource allocation disputes, high resources values corrected for time bias, etc. should be used and defended rather than losing some dispute with resource developers because researchers chose to be "purists".

The material in TN 8 reflects a shift in emphasis in developing the "loading curve" methodology that took place from 1971 until 1975 (when the note was put in roughly its final form). Since the author of this review is one of the co-authors of the note he knows that, originally, the paper was to be about decomposing all use of a park into two functions, a uniform function and a peaked function. After the actual estimation exercise began it was realized that such curves should have been developed for individual origin-destination flows. So, even though the methodology is described as if results had been obtained for origin destination (city-park) pairs estimation results are presented for the total use of certain parks for camping.

As research on park use has continued, it has become clear that to capture the real "structure" associated with visiting parks, it is not enough to develop uniform functions for different origin-destination flows: They should be developed for different classes of visitors. Different functions apply to day-users, long stay campers short stay local campers and non-local users who obviously had other trip purposes, etc. (e.g. see proposals for modelling in TN 40). But it was also clear that the CORD Study Park User Survey data were so poorly documented (see the CORD Study Data Documentation Volume) that the data set could not be used to estimate the coefficient for the kind of disaggregated loading curves to which reference was just made.

This obviously biased reviewer believes that this note gives researchers insight into questions that should have been asked in CORD Study surveys regarding types of park visitors. In other cases it points up technical problems regarding the need to build models for different types of users based on properly collected and weighted data. Also this reviewer believes that the use of the loading curve decomposition method does have great potential in aiding researchers to make effective use of the rather limited information that should be collected in most surveys.

In an organization which is supposed to be efficient in collecting information and utilizing it, it is important that there not be "overkill" in data collection, so if using such an analysis approach adds to the efficiency of use of information this is good. But, as to the implications in the article that the effects of weather can be derived, doing this has more doubtful merit. A practical question is: What information about the effects of weather on park use do researchers usually need to generate for managers or for planners? Obviously, if one has loading curves for a park and these are broken down by different origins and one has an idea how weather affects weekend, week-day etc. visitors from near and far, then one can take historic weather data and see what effects weather is expected to have in the future. Unfortunately a park does not staff for the exceptional season and analyses may be of more academic interest than of practical interest. The idea of using such information in park design may have some merit, but in

reality the kind of weather information that researchers should make available to planners for master planning is down to earth description of the weather in terms that relate to the facilities that they are considering. If weather is often bad so that some of the kinds of users who are predicted to come to the park would not want to be outside, the researchers may ask the planners: Is there provision for an indoor interpretation centre or are there some alternative activities indoors that relate to the objectives and design of the park and such that weather will not be a problem in encouraging use of the park?

The previous points make it clear that much work needs to be done before the "loading curve" methodology can either be endorsed for some purposes or generally rejected as of little use except for some academic research projects.

In reviewing TN 21, one could present a commentary on what happened in CORD Study and Parks Canada Park User Surveys from 1968 to 1974 but it would be very similar to the "hindsight" history presented for TN 8. This is because what is presented in the note is some information about a methodology that evolved. However, introductory comments to this chapter and overview comments in Chapter XI cover some relevant background details. So some specific innovations in survey weighting and data collection are noted both to bring them to the readers' attention and to be able to contrast their relevance to general needs for data collection analysis methodology with other methods of data collection which this reviewer now sees as more important in meeting most of Parks Canada's needs. Regarding data weighting, a procedure was employed that filled the time spent on lunch or on other breaks by interviews. One has seen that such gaps were "filled" by data that were collected near the time at which a break was taken. This should help to ensure that the interviews as nearly as possible "represented" the data that would have been collected in the period in which no interviewing took place. In many cases all that is done in a survey is that information is collected for a certain day on the total number of vehicles entering a park, and the questionnaires for that day are given a weight that establishes what part of total traffic (how many vehicles out of the total traffic) a certain questionnaire should represent.

This brings up the point that the weighting for a particular interview is much more dissagregated under the system presented than under usual weighting procedures. The fact that information collected in each half hour is related to entering traffic during that half hour (and that this is done on the basis of the breakdown of that traffic by origin, etc.) reflects a legitimate concern with getting as much information out of a given amount of labour input as possible (as well as a concern with accuracy). By having what is described in the article as a "floating sampling rate", it is possible to have field workers work hard when traffic is heavy (by making contact with people in as many of the vehicle as possible that pass through a gate) and at

the same time work as hard as possible when traffic is slow by getting interview information from people in all of the vehicles that pass through a gate. One should note that the survey strategy used by Parks Canada from 1971 - 73, which involves getting what is called "entry record information" from every vehicle, is important because many of management's questions can be answered by using only entry record information most of which is gained by simply observing a vehicle and its occupants. These figures can be obtained very accurately because many vehicles can be stopped when only one or two questions are asked (e.g. do they plan to stop in the park). If the parties in the vehicles do not hand back their questionnaire (and 50% do not) this entry record information can still be used in improving the weighting of those questionnaires that are returned.

The preceding comments serve to acknowledge that much of what is recorded in the TN involves justified modifications to usual survey procedures that either serve to improve accuracy statistically and/or increase the cost efficiency with which a given level of accuracy is attained. However, it must be acknowledged that development of computer programs to process the data collected, the rather time consuming procedures of defining appropriate weights for different survey days for which estimates had to be made, etc. involve much more work than occurs when a survey is processed by simply specifying a collection of day-by-day weights to be associated with all data collected on those particular days. Obviously, depending on what accuracy of results is needed, there may be justification for employing a very simple survey strategy. The amount of time that survey staff will be used (related to the total data to be collected) and the improvement in accuracy attained by using more sophisticated surveying procedures that increase processing and editing costs, and use excessive manpower, etc. often justify "simplistic" but well thought out survey procedures. But no comparative accuracy figures, procedures for determining what accuracy will be achieved one way or another, etc. are currently available so that the best thing to do in a given situation is often problematic.

Possibly the most important thing to realize regarding Technical Note 21 is that it presents details on a survey procedure which, although carried out from 1971 to 1973, was not the best procedure for collecting the information for which there was really a need. One can now see that manpower was used in an inefficient way in counting the vehicles: traffic counters that cost less than one field "surveyor's" salary for the summer could have been used. One may also note that traffic counters do not take afternoons off, nor do they take coffee breaks or lunch breaks: they usually work seven days a week for 24 hours a day with a minimum of care.

It is not unusual to find that there are money and manpower available to carry out a survey that are quite out of proportion to the resources available to decide what the

objectives of the surveys are and to take care in operationalizing these into a data collection analysis, report preparation effort. For example, if, as has been the case in the past, the primary use of survey information collected at National Parks is to develop good use estimates for those parks, it has been recognized that there is no need to stop vehicles at park gates. Presently a new method of getting data for use estimates is being tested in which entry to parks is recorded by traffic counters at all park gates. "Survey teams" simply obtain licence plate numbers and other data (such as the number of occupants of a vehicle) for certain blocks of time. Similar information collected at park facilities (campgrounds, etc.) allows the movement of a vehicle within a park to be traced and (for example) allows length of stay of visitors in a park to be monitored in a truly accurate way. It is surprising how much information can be generated in this way.

Now a reasonable question is: What is the cost of this procedure and are there operational problems involved in employing it that may mean that, in many cases, a survey strategy where entering or exiting parties are actually interviewed may produce acceptable results at a lower cost? One should note that having an objective record of what people did in a park is often superior to results obtained by survey because people often do not recall what they did or know exactly what something they did is called, so that they often cannot answer a questionnaire adequately. One example is that when the standard park users survey technique reported on TN 21 was "improved" and employed in a survey in Prince Edward Island National Park, it was found that so few people realized where they had been in the park that use estimates for the Park were 50 percent higher than the known actual use. (An error of over 250,000 visitors was made in estimating the number of out of province visitors to the park.) This kind of error simply cannot occur with a study in which licence plate information is recorded. In this latter type of study one is not dependent on a person recognizing that certain locations are park boundaries.

Thus although TN 21 has presented some useful innovations in survey weighting, it has also indicated that refining weighting to gain slightly more efficiency in estimates of some use figures may miss the real point of what needs to be done. It is impossible to stress sufficiently the importance of careful definition of information generation objectives. Collecting information that is more accurate than is needed, that is more extensive than is needed, etc. are park user survey inefficiencies that really need to be eliminated. However, eliminating them is far from simple and it is only as researchers proceed to build up a catalogue of the best current procedures for information collection to meet specific objectives that there can be widespread use of appropriate research tools.

The key need today in recreation research is careful definition of objectives of research and careful operationalization of these objectives in as efficient a way

as possible by a thorough description of exactly how such and such a table or factor analysis result will be presented to a planner or manager to answer his question. The researcher with practical concerns working for a parks organization or at a university cannot be expected to be totally aware of all of the statistical "tools" that are best to achieve certain ends for the variety of projects that arise. But this will be less of a problem when specialized researchers have produced (and updated on a regular basis) a procedures manual. Such a manual must not just be a survey procedure manual but must have statements of objectives related to an information need. Based on this, a discussion should present how a specific information gathering procedure is justified by explaining exactly how the data obtained are to be processed to produce the tables, etc. that are to be used in achieving the project objectives by doing (a)..., (b)..., etc. It is this kind of complete project analysis guide that is desperately needed. This approach to project improvement is not described in TN 21.

There is commentary elsewhere in this volume on TN 10, specifically in relation to Technical Notes 32 and 37. (See also various commentaries in Chapters VI, VII, IX and XI.) Actually, Technical Notes 32 and 37, as indicated in Chapter VI where these notes appear, deal with many of the matters that might be taken up in review comments here so the reader is referred to these notes for details on the possible applications of methodologies described in TN 10 and a critique of the methodologies.

The one point is not sufficiently stressed elsewhere concerning determining natural "classes of people" as opposed to mathematically definded homogeneous groupings. The concern is with a scheme that allows individuals to be defined as members of a class to which they belong even if some of their characteristics are at odds with some characteristics of other individuals in the same class. For example, who would think, seeing a tamarack without its needles, that although most people call it an evergreen, it is in fact a deciduous conifer. That its needles fall off in the winter is not the important factor to consider in classing this tree as a conifer. Similarly, in the context of the outdoor recreation demands study data, it is not surprising that in the middle 60's very few people on the Canadian prairies skied (nordic) during the winter. There were no ski hills! So in defining activity packages it is critical that a person not be excluded from a certain activity package which includes people with participation in other similar activities simply because at a given point in time they live in a region in which they do not have facilities for certain activities. Such people may even substitute snowmobiling for skiing so that their activity package appears to be more disparate with some people with whom they should "naturally" be grouped than if they simply did not ski.

The clustering computer program used in deriving the clusters presented in TN 10 was not set up in such a way

that these kind of considerations were taken into account. It is possible to argue that by using a special input-computer-program which prepares data for analysis in a special way, one could do a screening of information so that skiing in one area would be equivalent to snowmobiling in another. With data transformed in this way one could argue that more "natural" classes of people could be derived. Still, if one uses the "monothetic-divisive" clustering program used in TN 10, a person is excluded from a clustering because he does not "score on one critical variable. The answer is not simply to go to the kind of aglomarative programs described in the Appendix to TN 10. At least with these programs the fact that a person does not participate in one specific activity does not eliminate him from a cluster. One activity may weigh heavily in terms of a person not being included in a given cluster. No, regardless of which kind of clustering program is used, it is essential that much thought go into introducing availability of supply considerations into information on participation so that a clustering program can "evaluate" a given level of participation in terms of the availability of supply. If supply is available and a person does not participate in an activity, then an important question is: Is it the availability of supply for an alternative activity that has resulted in the lack of participation? Has substitution taken place or is this person legitimately different from others in terms of his preferences for activities? If the supply configuration confronting two people is similar and one participates in one activity and another person in another activity, substitution is probably not an issue. Still, even faced with common supply, one person may participate in one activity and another only because of the relatively equal utility of the two activities. But, when supply varies an assessment is much more difficult to make. Given the fact that TN 24 has shown something of our limited capability to indicate how much supply a person perceives to be available, one may see the impossibility of making much progress in studying substitutability or improving clustering until there is some progress in measuring people response to supply in making decisions (this is taken up in some detail from a theoretical perspective in TN 33).

Obviously, much more theoretical writing on the problem of forming clusters in a behaviourally meaningful way must be done in parallel with discussion of how this theory can be operationalized in terms of using various clustering techniques. TN 10 has only demonstrated the feasibility of two techniques for extracting information about clusters of people and clusters of activities. Furthermore, in the perspective of this reviewer, the procedure of factor analysis actually has little application because it is not tied closely to behavioural considerations except in the context of an aggregate theory which should be of little relevance in recreation planning. So in the note one has really only seen demonstrated one analysis procedure which may eventually have a great deal of utility but now has

limited utility (see TN 32).

TN 19 is a much simpler note on which to comment than TN 21 or TN 10. It has simple objectives that were attained and gives a relatively straightforward way to obtain more efficient estimates for the parameters of gravity models than are obtained by the ordinary least squares procedures usually employed by researchers (e.g. as used in TN 1, TN 4 and TN 18). Also it was possible to define an absolute test of model adequacy. The importance of this finding and the practical application (and implications) of it are adequately stressed and explained in the note.

There is one point which is not stressed, on which some readers may find it useful to have some comments. If a model is not structurally adequate for the data to which it is applied, the use of GLS estimation does not necessarily result in improved estimation efficiency. Yet this should not be taken as a reason to avoid using GLS estimation. At least if GLS estimates are used, valid tests on model adequacy can be used to indicate that a given model is inadequate. Certainly nothing is lost by using GLS estimation. And what is gained, as is stressed in the note, is that one can examine the residuals giving the difference between observed flows and their predicted flows to see how to improve a model.

TN 36 cannot be faulted on the basis of the achievement of the basic objective that was set for the research reported. The author proceeded in a rather elegant way to show the value of R^2 that would be expected when models like those presented in TN 12 were developed. However, some readers may wish that the author had used a rather more easily understood derivation that does not involve using the calculus. Dealing with the problem using discrete distributions and "simple" probability theory is possible and quite easy. It is probably also true that the reader who has a strong enough methodological orientation to read the article has the calculus necessary. Still, in the view of the reviewer, the average reader has a better chance of getting a clear idea of what has been proved, why and how if the discussion is translated into one using summations and "discrete" probabilities.

The substantive grounds on which this article can be criticized obviously do not relate to the main objective of the article. Rather, when the author proceeds to introduce a test for the structural adequacies of a model he does not consider that the ordinary least squares estimation approach on which his formulas are based gives residuals which should not be used in the test proposed. Basically, the author (as indicated in TN 12 and a footnote in TN 20) is working with a model in which the assumption is that one is calculating probabilities of people's participation. These probabilities (the dependent variable) when estimated define a heteroscedastic dependent variable distribution, so the author's test for structural adequascy must be made taking this into account. His test equation should be replaced by:

$$
X^2(N-df) = \begin{cases} @E\ (O(k)-P(k))^2/P(k)(1-P(k)) \text{ for all } k, \\ \text{WHERE } 1-d > P(k) > d > 0 \\ \\ @E\ (O(k)-P(k))/d(1-d) \\ \text{for } P(k)>1-d \text{ or } P(k)<d \end{cases}
$$

The reason for using this formula is indicated in the note below. If one estimates the model parameters, considering the heteroscedasticity of the dependent variables, then it is not only necessary to use the equation given above. The formula would be used after the results of estimating the model a first time have been used in a second GLS estimation cycle where, for example, a first estimate of {p}(i) is considered to have a variance {p}(i)(1 - {p}(i)) if 0 < d < {p} < 1 - d < 1 and d(1 - d) otherwise. In the computer program developed by Parks Canada for this, d = .01.

SUPPLEMENTARY NOTE

To try to give the reader further feel for how CORD Study research has progressed, the following note has been added to this chapter review, rather than changing the material on the "chi-squared test of model adequacy" just presented. While the author of this review was working on revisions to what had been thought to be the final version of TN 6 and reviewing the Smith and Cicchetti article (see Appendix A), the practical import of the following conclusion by Smith and Cicchetti became clear:

> Most survey research using dichotomous dependent variables for the estimation of linear probability functions utilizes fairly large data sets (in excess of one hundred observations) for statistical estimation. As a consequence, "probit-like" estimators impose substantial computational costs. Therefore, OLS or GLS procedures are frequently chosen. While our results cannot discern the loss in efficiency if an OLS estimator is utilized, they do indicate that there is little or no gain from Aitken estimation for such large data sets. Moreover, traditional hypothesis testing with Student's t-test for the coefficients of such models can probably be expected to yield reasonably powerfull tests with large samples.

When the estimate of variance in predictions of number of male hunters in Quebec were computed and it was noted that with regression coefficients based on 1291 observations, both unweighted and weighted regression results gave ecu ally accurate predictions. A question had to be answered! Why go to the trouble and expense of carrying out weighted regressions? In reality, expense was the big concern because each weighting iteration requires that data on every observation be weighted, that weighted

means be computed, etc. until finally after a matrix inversion, which may be costly, is carried out and new regression coefficients are produced. For some CORD Study research, getting weighted regression results based on obtaining initial estimates and then doing a GLS estimate, would have involved reading data on 2,000 people about 100 times and inverting a 40-by-40 matrix the same number of times.

Why the expense? At first, the obvious answer appeared to be so that tests of model structural adequacy, such as the one described just before this supplement, could be performed. However, some thought made it clear that if parameter estimates are not affected much by weighting when sample sizes of concern are 600 to 25,000 (which are what are being used in CORD Study analyses), one could use the U and B(.)'s computed in the unweighted regression to calculate:

Chi-squared(DF) = @E ((O(i)-P(i))^2/(P(i)(1-P(i))

WHERE the sum is over i observations;

if P(i) or 1-P(i) is less than .01 then their product is set to .01;

DF is the number of observations minus the number of parameters estimated;

O(i) are observations;

P(i) are the OLS predictions.

If the observations are not stored in the computer for carrying out a regression, when a regression is carried out (and from a cost efficiency point of view should not be), the kind of chi-squared values suggested can be computed by writing out the regression equations along with dependent variable identification, so that even if 50 equations are produced based on the same explanatory variables (or fewer dependent variables dichotomized in different ways), one need only read the dependent variables once and compute all the chi-squared values to test the adequacy of say the 50 models.

Actually, when the chi-squared values were being generated as suggested above, other useful statistics on the "quality" of a given model could be generated. A problem is that almost invariably there are P(i)'s that are less than 0 or greater than 1 and thus do not make sense as probabilities of participating, or when otherwise interpreted. Counting such cases based on how negative they are and even writing out data on them for further analysis can be very valuable. Often, seeing what characteristics "outliers" have is important in identifying problems with a model.

In closing one should note that the Appendix to TN 29

shows why the chi-squared test of model adequacy for hunting carried out in TN 6 did not show that the model was inadequate. Only with the over 25,000 observations available in the data used to compute supply or with similar large data sets does the "supply factor" sum of squares become large enough compared to the TSS that it would be detected by concluding that structural error was arising for some reason.

But as reported in TN 29 (and in TN 6 and TN 20), if supply factors or other "effects" that should be considered are ignored, predictions made using a model may be seriously in error EVEN if estimates of the accuracy of the predictions show only a few percent error is likely to occur. Accuracy estimates, based in the method presented in TN 6, are appropriate IF a model is structurally sound. As stressed elsewhere in this Volume, the kinds of chi-squared test introduced at the end of this review are weak tests. If one rejects a model as unsound, he can be confident but if he accepts if as sound he cannot be confident that estimates made using the model will be as accurate as he may estimate, because undetected structural problems with the model may lead to substantial biases in many estimates.

It was only while these review comments were being prepared that it was recognized that the use of the kind of iterative variance estimation (heteroscedasticity correction) just described gives a test of model adequacy similar to that developed in TN 19. When GLS (weighted) regression was used in TN 29 to explain peoples' participation in activities after the second estimation cycle one finds that:

Residual Sum of Squares = 31759

Degrees of Freedom = 25219

and because the regression has been carried out by normalizing every dependent variable observation by its variance the residual sum of squares is a sum of squares approximately zero-one variables with 25219 degrees of freedom if the model is structurally sound. But one can test the value of RSS to see if it probably came from a chi-squared distribution with 25219 degrees of freedom by considering that because $RSS = X^2$, $d = 2(RSS) - 2(25219)$ is approximately an observation of a normal zero-one variable if the model is structurally sound! But d congruent to 18, which means that RSS is too large by so much that it would have the same probability of occurring as an observation of 18 or greater in sampling from a normal zero-one variable. This will occur less than one time in 10**50 if a rough underestimate is correct. Obviously there is room for improving the TN 29 model.

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CHAPTER VIII

ALLOCATION AND EVALUATION MODELLING

INTRODUCTION

The Technical Notes in this chapter logically fall into three groups. The first group, on demand function estimation, contains only one note and could just as well have been associated with TN 38 in the last chapter. In it the reader will find that Cheung and Knetsch have developed an answer to the question: What effect does time bias have on the value of a Canadian Park? This matter was considered important enough by Knetsch that he and Cheung corresponded between Canada and Malaysia in order to bring the note into its final form. Ignoring time bias in estimating the value of a park means underestimating that value and risking the loss of the park (or the land that could be developed as a park when in fact some other use is less valuable, at least in terms of the economic theory behind the demand model).

The first large group of notes in this chapter deals with allocation models and allocation evaluation models. All of the research presented arose independently of the CORD Study. The development of the potential model originally ocurred because of a Canada Council-supported project (under Dick Butler, Department of Geography, University of Western Ontario) to develop social indicators as part of the Canadian Social Indicator Project. The fortunate happenstance is that CORD Study data were available when Butler was to work on recreation indicators and this facilitated the development of a methodology for indicators which is reported on in TN 5. Butler's original project was revised by Ross (with further input by Ewing), resulting in the final version of the paper. This evolution of the note from conception to completion was over a period from 1971 until 1975.

TN 17 arose because Ontario (as part of the tourism and outdoor recreation planning project, TORPS Study) was very explicit in stating objectives of policy, planning etc. When it was recognized that the large scale planning model would not be available when they needed input for certain decision making, the question was asked: What can we do with that part of the work which is completed now? So a model was developed that could be used with information on the location and amount of supply, and location and amount of population along with the policy information about how policy objectives were to be pursued to produce an output that showed the nature of the present allocation of supply with respect to population. The model which produced a pressure (per capita amount of supply) could also be used to indicate how a park development option to be pursued would

change pressure on facilities (hopefully in a desirable way).

The sensitivity testing of linear programming paper was prepared because of CORD Study researchers' concern about the growing use of automated evaluation methods without the necessary awareness of the difficulties that can be encountered when such methods are used. Work in which a CORD Study researcher (Auger) had been involved, and which built on a paper by Manning who was with the Canadian Forest Economic Research Institute, was the stimulus that prompted Auger and Cheung to critique Auger's work by looking at what might be wrong with a linear programming solution to the problem that Auger solved using linear programming. Actually, it is quite interesting that doing a sensitivity test of the solution to a fairly arbitrarily selected problem (which was originally designed to show the merits of using linear programming) results in such clear-cut evidence that using linear programming without doing sensitivity analysis may result in making a poor choice of projects! This is true even when one does not consider the matter of whether a good objective function can actually be defined.

TN 25 was prepared because planners and managers often have little time to do research before making a decision. So in a situation where a decision must be taken quickly by comparing two or more alternative proposals it is important, when operating under PPBS, to carry out as rigorous an evaluation as time allows. This article critiques a traditional, quick evaluation method and offers constructive suggestions for modifications that result in defining a new procedure which is explained and illustrated.

The methodology in TN 26 is little changed from the form in which it was developed in 1967-68 in order to study the recreation needs of the people in a city. It was revised only in 1975 when it was realized that no analysis methodology had been presented which could use CORD Study National Survey data to evaluate current participation levels in order to make recommendations for facility development, for program evaluation or for program planning. This methodology is oriented to presenting results to planners and managers who want to compare the way in which people in different areas who are in the same age-sex group are being serviced. Obviously whether such a methodology should be used depends on the objectives of the planners and managers.

Only a few brief notes are required concerning the concluding Technical Notes in this chapter. TN 39 was prepared because it was recognized that a volume such as this one should have something in it on Canadian work on The Economic Impact of Parks. The lack of any guideline work on preparing impact studies was so pressing in the late 60's that Parks Canada produced a statement as part of the work carried out in evaluating the impact of what was then the proposed Gros Morne National Park. The note which appears here is a collection of still relevant extracts from that statement. TN 40 is in some respects the end product of

research that began in 1964 when, in line with good research practice, information was collected about the area in which a new park was to be created so that its impact could be evaluated later. After the park was created and after the Canadian Outdoor Recreation Demand Study had been conceived and begun (actually in 1973) data were again collected in the area of the park. Many of the people then interviewed were people from whom data had been collected nine years earlier. So, work on TN 40 proceeded based on before and after data. Despite the fact that critical information was not collected in 1964 it was still possible to glean something about the major discrepancy between the original plan and the actual situation in 1974. Thus TN 40 shows planners and managers, from the experience of the development of a particular park, what might have led to clearer statements of expectations and a more reasonable relationship between a planned product and what exists at a subsequent time. Finally, the other note in this section was prepared because there was a need for information on the success or lack thereof of commercially operated campgrounds. The original author of this article had carried out such research in Western Canada and for the preparation of this Note carried out similar research in Eastern Canada so that he was in a position to make statements that empirically relate to both Eastern and Western Canada. In 1975, others became interested in using O'Riordan's work with respect to policy issues, and this interest in reflected in current version of TN 41.

THE ECONOMIC VALUE OF RECREATION AREAS: THE CASE OF SASKATCHEWAN PARKS

J. L. Knetsch and H. K. Cheung

ABSTRACT

Contrary to what many have believed, outdoor recreation is amenable to economic analysis and is quantifiable. The expression of the economic value ascribed to the use of a park is the visitors' willingness to pay for this use. More operationally, this can be measured as the area under the aggregate demand curve for the recreation services provided by such use of resources, over a period of time. To yield a net figure, the variable costs (usually of operation and maintenance expenses associated with the use) would need to be subtracted and any external values, such as preserving scientifically valuable artifacts, would need to be added. For most areas, the major problem centers on establishing a reasonable estimate of the demand schedule.

The paper describes a method whereby a meaningful estimate of economic value for a park can be derived. Data from a series of parks in Saskatchewan and a hypothetical proposed area are used to illustrate the method. The initial procedure is to estimate a relationship between use of parks and the various factors that influence this, such as population proximities, attractivity of the parks, and competitive facilities. From this use relationship a demand schedule can be imputed for a park by hypothesizing increasing costs to visits and estimating the consequent expected decrease in use totals. Then, it is possible to calculate the economic value of the park by measuring the total area under the demand curve obtained.

INTRODUCTION

Substantial sums are devoted to the provision of public outdoor recreation facilities and far larger ones are in prospect over the coming years. Presumably judgements of comparative worth of alternative proposals or of benefits and costs could be improved with some reasonable estimates of expected demand for alternative sites and meaningful measures of the value of such use of resources. This is not to suggest that such estimates should be the sole determinant; other factors such as the distribution of sites, availablilities to all segments of the community, and provision of a wide range of types of facilities should also be considered. Predictions of the use expected at a new facility can usefully be based on experience at similar

existing sites, by casually noting similarities and drawing analogies or by establishing more formal statistically derived relationships. The expression of the economic value ascribed to the use of a park can, for the most part, be taken to be the willingness to pay for this use on the part of visitors to a park. More operationally this can be measured as the area under the aggregate demand curve for the recreation services provided by such use of resources. To yield a net figure the variable costs, usually of operation and maintenance expenses, associated with the use would need to be subtracted; and any external values, such as preserving scientifically valuable artifacts or preserving future options for use, would need to be added. For most areas, the major problem centers on establishing a reasonable estimate of the demand schedule.

The intent here is to establish demand relationships and to derive a meaningful estimate of economic value for a park, using data from a series of parks in Saskatchewan to illustrate the methods. Parameters estimated on the basis of visit patterns to these parks are used to project the demand for a hypothetical proposed area and for the economic value of the expected recreation use. The initial procedure is to estimate a relationship between use of parks and the various factors that influence this, such as population proximities, attractivity of the parks, or competitive facilities. From this a demand schedule can be imputed by hypothesizing increasing costs to visits and estimating the consequent expected decrease in use totals from the visit estimation model.

PARK VISIT MODEL

Visitor patterns for eleven provincial parks and one national park in Saskatchewan were studied.

Multiple regression of the visit rates from the origin areas to the twelve parks, and the four independent variables, resulted in the equation:

```
(1) V(i,j) = -2.693 - (663.70/D(i,j)**3/2) + (580.837 P/
             D(i,j)**3/2) + 16.616(T(j)/D(i,j)**3/2) -
             178.760(P(i)A(i)/D(i,j)**3/2)
```

where V(i,j) is the number of vehicles, in hundreds, travelling to park j and from origin i; D(i,j) the road distance in miles between i and j; P(i) the population, in thousands, in the origin areas; A(i) the measure used to determine the accessibility of alternative parks for people at each of the origins; and T(j) the factor used as an index of the attractivity of each of the parks.

Each of the coefficients was found to be significant from zero at the 5 percent level, and 90 percent of total variance among the observations was found to be explained by these terms. While each of the four independent variables was found to be significant, the term P(i)/D(i,j)**3/2 alone

accounted for the major proportion of the variation, reflecting the very strong dependence of Saskatchewan day-use recreation activity on proximity of population centers to the areas. (A series of different exponents on the distance term ranging from 0.5 to 3, were tested with 3/2 and 2 being equally satisfactory and superior to the others in terms of the explained variations.) The relationship implied by the equation seemed plausible in terms of what is known about recreation visit patterns, especially in its accounting for the expected interactions among the variables and the strong influence which proximity exerts on visit totals.

The use estimating equation should provide a reasonable basis for predicting, for example, the expected use of a new or proposed site in the region. As such it should be a useful tool to deal with a common planning problem. However, beyond this it can also serve as the basis for estimating the value of such a proposed recreation area.

VALUE ESTIMATION

An estimate of the probable use of any proposed site in the region, similar to the parks included in the original surveys, and a demand schedule associated with this use, can be derived from the recreation visit model.

Given a proposed location, values for the distance, population and alternative attraction variables can be calculated just as they were for the existing parks used in the original analysis and as they were in TN 1. The numbers of miles to each origin resident area and the size of the population are either known or can be easily looked up or measured. Similarly, the alternative factor values can be computed for each park. The attractivity or facility index of the proposed site must be based on an assumed development or provision of facilities. Given the values for the independent variables, an estimate of attendance for the new area is obtained by substituting in the equation to obtain the number from each origin area, and summing over all of them to reach the total.

For the present purpose a hypothetical proposal is used for a park that might be located a little over 100 miles southwest of Saskatoon and not very close to any sizeable population centers, and having a fairly typical complement of facilities and attractions. For this set of assumed conditions the TN 1 model can be used to predict a yearly total of 13,420 vehicle parties that would visit the site - a number slightly below the average of 14,404 vehicles that went to the twelve parks used to generate the estimating parameters. The 13,420 estimate can be taken as one point on the demand curve to be imputed for the purpose of value determination; the quantity at zero price for the use of the services of the site. Estimating other points requires the further calculations of expected use but at what can be taken to be various increases in the cost of entering the

park. This can be done through the use of the distance term in the equation. Distance is in effect a proxy for price in the sense that increases in distance from origins to parks serve as a deterrent to visits. Initially, it can be assumed that the cause is the increased cost of travel associated with increasing distances. (The original suggestion for this procedure was given in Reference 12.) As the present case deals only with day-users, or those without expenditures connected with overnight stays, the variable costs of vehicle operation can by and large be taken to represent the cost constraint. For the present(1973) purpose this was assumed to be $0.07 per mile, or $0.14 for the two way distance.

Successive points on the demand curve can be imputed by summing the estimated visits from each origin under assumptions of successive added travel costs in the form of added distance. For example, the visit total corresponding to a "price" of $4.20 per vehicle is found by adding 30 miles (30 miles at $0.14 per mile is $4.20) to each of the original mileages for each of the origin areas. An estimate of use can then be made for each and the result summed to give the total visits. In this instance the calculations yield an estimate of 5,450 vehicle parties. That is, 13,420 parties would be expected at no increase in travel cost, but this would fall to 5,450 if each were faced with an added outlay of $4.20. Other points can be derived in analogous manner to impute the relevant demand curve for the site; and the area under the curve can be measured to yield an estimate of the value. In the present case the demand curve calculated in this manner indicates a value of about $90,000 for the season.

TIME BIAS

The model is used to develop an estimate of the demand curve based essentially on observed behaviour of visitors. That is, the empirical relationship between distance and visit numbers is estimated from actual use response of visits to Saskatchewan parks. It therefore avoids one source of arbitrariness of presumed response to proposed circumstances. However, the resulting estimate is subject to a serious bias. This is caused by the implicit assumption that the only reason that visit rates vary between origin centers of varying distances to a park is the difference in money outlay necessary to travel the added distance. This is certainly not likely to be the case. In particular it would be expected that the time required to travel greater distances would be a major reason for the observed variation in visit rates.

Thus, when the model implies how many visits will fall with increased money costs, the decrease is consistently over-estimated. The visit rate for any origin will decrease, but not to the extent indicated by the observed distance decay function, for only money costs are assumed to have

increased with the travel time remaining constant (when the simple TN 1 model is used.) For instance, if money costs equal to an added distance of 30 miles were added to an original distance of an origin from a park of 20 miles, the visit total could not realistically be expected to be that of an origin 50 miles from the park. The money outlay is that of 50 miles, but the time cost is still that of the original 20 miles. The demand curve is then conservatively biased for all of the points except the zero "price" point. More visits would in fact be expected for each assumed money cost increase, than would be calculated directly from the model.

A CORRECTION

The bias problem resulting from a lack of an accounting of the effect of time could be overcome if it were possible to estimate parameters for a model that would have both travel time and money costs as separate variables. The money costs could then be incremented for each origin with travel time held constant in the same way that the factor measuring alternative or substitute areas is now maintained at a constant level for each origin. However, this is usually impossible owing to the high correlation between travel time and money costs among trips of varying lengths - longer journeys cost more and take more time (see TN 33). Toll roads, for instance, could introduce some variance but in the main it is impossible to establish meaningful estimates of the independent effect of each.

An alternative procedure can be used to make a correction for the present omission. This is to imply a trade-off between time costs and money costs by replacing the distance term in the model with a "composite" variable encompassing both time distance and money distance. (See Reference 12.) Instead of the term D(i,j), a substitute combining "money miles" (D(C)) and "time miles" (D(T)) can be substituted.

The specific form of such a composite variable will reflect the presumed shape of the money-time trade-off expected to prevail. For example, if a linear trade-off is judged to be appropriate and if it is assumed that the time it takes to travel a mile is of equal importance in restraining visits to the money necessary to travel the same mile, then a variable (D(C) + D(T)/2) might be used. Thus for an observation or origin having an original distance value of say 20 miles, this would be replaced by ((20 + 20)/2); which equals the original 20. However, to calculate the demand schedule, increments are made to the D(C) term while holding D(T) constant. The resulting calculations yield a correction for the time bias, in that an accounting is made for effect of travel time. It is, of course, explicitly dependent on the chosen form of the variable.

An additive form will imply a linear trade-off. But different weights can be used to reflect the relative

importance of travel time and money costs as impediments to travelling greater distances. For example, if it is hypothesized that the effect of the money it costs is twice as important as time, this can be reflected by the use of a variable (2/3 D(C) + 1/3 D(T)). Any weights can be used, with a zero weight for time being the original formulation which took no account of the time bias problem.

A curvilinear trade-off could be reflected in a variable such as (D(C) D(T))**1/2, with differing shapes requiring differing weightings. A form convex to the origin might be reasoned on the presumption of an observed strong tendency for the marginal effect of either an added minute or an added dollar to have a diminishing effect on decreasing visits the longer the trip - an added increment has less effect on trips of 100 miles than on ones of 10 miles. (The convex notion is similar to supposing convex indifference curves from generally observed diminishing utilities.)

A more definitive choice of variable form and weightings should in time be amenable to empirical verification. Some evidence is provided by Mansfield which suggests that the weight or importance of time in overcoming greater distances to recreation sites is perhaps of greater importance than the money costs involved (see Reference 47). As he notes, the issue is the disutility of time traveling to a recreation facility and not that of traveling, say, within a park. By the same token, it might well be expected that the average impediment of time might well vary, for example, with the nature of the scenery or local amenity. Travel time would be less of a burden for a journey through semi-spectacular landscapes than one through more drab countryside, and the weights for the composite variable could, in principle at least, reflect this. At present, alternatives that appear to encompass reasonable assumptions can be used.

Another attraction of this type of formulation is that it provides a more consistent rationale for cutting off a demand curve that is asymptotic to the vertical axis, for purposes of counting of benefits (i.e. measuring in dollars the area under the curve). This asymptotic property can arise, for example, when a model is estimated in logs, or when a constant term in other forms is positive. If it is known from the original data that about the farthest source of visits is, say, 200 miles, then when the total value of D(T) and DC equals 200 this can be taken as the cut off. This is, however, quite different from having D(C) alone be 200. For example, if (D(C) + D(T))/2 is used, an observation starting at 20 miles (i.e. both D(C) and D(T) being 20 and with (D(C) + D(T))/2 being similarly equal to 20) can allow D(C) to be incremented to 380 before the total value of (D(C) + D(T))/2 reaches 200. This reflects the more realistic possibility that it is not just the money cost of travelling 200 miles that has cut off the visits, but a combination of both the time and the money involved; and consequently, if the time is less than that needed to go 200

miles, then the money outlay could probably be significantly higher before the combination forces the visits to zero. And, of course, the point at which this occurs is given by, and is thereby consistent with, the 1 to 1, or 2 to 1 or whatever combination of weights that is used in the formulation fo the variable.

RESULTS

Without more evidence on the shape of the trade-off function between time and money, the more conservative linear form was pursued here. While any number of relative weights might be used, two were selected to carry through the analysis. The first assumes that the effect of time and money on visit rate decreases are equal, with the variable (D(C) + D(T))/2 consequently used. The second, assumes that money is twice as important as time with the variable (2/3 D(C) - 1/3 D(T_) used. As the resultant demand curve does not reach an intersection with the price axis, a value of 200 miles for the composite variable was taken as a cut off. (As the curve was close to the axis, the resulting value estimate was not very sensitive to this particular choice of 200.)

The several points on the demand curves were calculated by incrementing D(C) while holding D(T) constant for each contributing origin area for the hypothetically proposed park. The area under the curves might then be taken as an expression of the present or initial year's economic worth of the recreation services that would be afforded by the park. In this case the estimates were approximately $159,000 and $125,000 for the equal time-money weights and the double money weighting respectively. Some projections over time would need to be made, the variable costs subtracted and an allowance added for non-user benefits, to arrive at a more complete evaluation of the total net value. However, the method appears to yield reasonably defensible estimates.

CORD STUDY TECHNICAL NOTE 5

POTENTIAL FUNCTIONS IN EVALUATING THE NEED FOR RECREATION FACILITIES

J. H. C. Ross and G. O. Ewing

ABSTRACT

Planning the provision of recreation facilities is currently hampered by a relative lack of preceding research and a marked absence of established standards. To evaluate recreation opportunities provided by sites such as provincial and federal parks in Canada the authors suggest a method of quantifying each opportunity, a measure they call the Opportunity Quotient, that can be applied to any location.

The paper discusses the philosophy underlying the Quotient and the problems its use entails. It treats the Quotient from the assumption that competition for recreation resources is best measured at the recreation sites themselves, but it also offers an alternative formulation based on assuming that the competition for resources is exerted at the point of residence of each individual, and that it is this force which drives one away from home to seek recreation opportunity.

A practical example of using 'the quotient' to assess opportunities is given, based on the Windsor-Quebec Urban Corridor project of Environment Canada.

MEASURING RECREATION OPPORTUNITY

The combination of pressures upon limited physical resources and increased public awareness and desire for leisure activities throughout the 1960's and 1970's have resulted in great concern with recreation and provision of facilities for recreation pursuits. Individuals and governments are now actively involved with studying and planning in these areas. The classical planning problems of evaluating the present situation and determining the needs and wants of the population have assumed new importance. In the recreation field, however, the difficulty of coping with these problems is amplified by the relative lack of preceding research and the marked absence of established standards.

Evaluation of the recreation opportunities provided by recreation sites (such as provincial and federal parks in Canada) is of current interest to the Outdoor Recreation and Open Space Division of the Lands Directorate, Environment Canada. To this end, a method of quantifying the opportunity is suggested which, when applied, yields a measure called

the Opportunity Quotient. Insofar as the quotient can in principle be calculated for any point in the country, the spatial variation in the level of opportunity can be mapped. This paper focuses on rationalising the formula used to define the quotient.

THEORY

Opportunity for recreation is obviously dependent upon the relationship between the supply of recreation sites and the demand for them. In fact, the ratio between a measure of supply and a measure of demand can reasonably be called an index of opportunity. But a crucial and most difficult problem in defining a particular index is establishing a means of effectively representing both factors in such a fashion that values of the ratio for different places really reflect their differing levels of recreation opportunity. (Comments in Chapter XI indicate that some hold the view that the measure need only be relevant to policy, and may have nothing to do with "really" reflecting difficult levels of opportunity.)

In urban areas, a commonly used measure of recreation opportunity is the ratio of total city park acreage to total city population. Such a ratio is often compared to some accepted planning norm of park acres per thousand people (see TN 26). Even at the city level, it can be argued that this ratio fails to take into account variations in access to a park as a function of distance from home to parks. Clearly a family within 100 yards of a city park is likely to make more use of it than a family whose closest park is a mile or two distant. An additional limitation of the above approach is the concentration on park acreage as a measure of supply, to the exclusion of any other park characteristics, such as the nature of a park's facilities. At the scale of regional and national parks, the same considerations of access and park facilities remain relevant. Therefore, an index is required which incorporates these elements, in addition to those usually considered in measuring the supply/ demand ratio.

MEASURE DEFINITION

To begin, consider a single location. What is sought is an index of opportunity of people living at a location to use public recreation facilities, expressed in terms of the supply as measured by the number of facilities available to them, the characteristics of these facilities and their accessibility from these location. The index should include a measure of demand for these same facilities, so that the extent of pressure on, or competition for them, is known and used to adjust the supply measure. In this paper, the only facilities considered are parks.

An index of location i's supply provided by a single

park j, discounted by the distance between the park and i can be defined as A(j)/D(i,j), where A(j) is the attractiveness of park j and D(i,j) is the distance from i to j. Given that ratio, an obvious way to measure origin i's total supply is to add together all the A(j)/D(i,j) ratios for parks accessible to that origin (within some arbitrary distance). (On problems with the convergence of the sums of such ratios see TN 3.)

The multiplying factor park attractiveness is used in the formula to imply that "something" about a park really determines the effective supply of park-based activities to the public. The more attractive a park to potential users, the more likely people are to use it, and therefore the more effective it is in adding to the supply people perceive. The determination of a park's level of attractiveness is a considerable problem in itself which is not pursued here. A discussion of various methods of estimating park attractiveness is to be found in Chapter III of this volume. Frequently, though, simple variables which are assumed to be closely correlated with park attractiveness, such as park acreage or number of campsites, are used as expedient surrogates of attractiveness, for lack of estimates of attractiveness itself (see TN 9).

However, returning to the main theme, in defining a sum of A(j)/D(i,j) ratios, something has been implied about the relative importance of attractiveness compared to distance in terms of the effect of these factors on supply. Assume for the moment that the major determinant of attractiveness is park size. As it stands, the implication is that one park of say 200 acres at 1 mile from i contributes no more to i's supply than another park of 2 million acres at 10,000 miles. Or, put another way, two origins would be implied to be equally supplied if one had a 200 acre park a mile away and the other had a 2 million acre park 10,000 miles away. The questionable validity of such an assumption leads one to consider what the weights are which should be applied to the size and distance terms to make the relative values of different A/D ratios more "realistic".

In the context of the example the question is more properly defined as: How do people trade off size against distance when evaluating their access to supply? If empirical evidence is available as to the nature of the trade-off between attractiveness and distance the earlier expression may be appropriately modified to give, for example, A**a/D**d, or some other such combination of transformations. For example, if the appropriate function was D^2, then in the above example about two parks, the smaller at one mile would contribute $200/1^2$, i.e. 200, to one origin's supply measure whereas the large park at 10,000 miles would now contribute only $2{,}000{,}000/10{,}000^2$, i.e. 0.02, to the other origin's supply measure. Obviously, vastly different conclusions are reached about the relative supply to different places, depending on the relative "weight" given to attractiveness and distance. Since the assumption of any other weights, in what follows the

function, $f(A/D)$, that is added up to get a supply measure, is defined in the non-committal $f(A/D)$ way just introduced.

To this point there has been no consideration of the effect of the presence of numerous users at the same park site and the possible reduction in the individual's opportunity to enjoy a park's facilities as the number of competing users at a park increases. A park surrounded by several nearby cities is likely to be frequently crowded, and, because of the congestion, the kinds of benefits that such a park is thought to provide are likely to be less available than if the same were close to only one small town. Thus, the potential supply offered by a park j to an origin i, defined as $f(A(j)/D(i,j))$ should be discounted when the number of users at j, $U(j)$, is large. The nature of the relationship of crowding and supply unfortunately requires empirical verification. Still, it seems plausible that disutility and use are related so that the larger the size of the park (S) and its facilities, the lower the disutility associated with a given $U(j)$, a positive monotonic increasing S-shaped curve. Regardless, a generalised definition of the potential supply discounted by the number of competing users is:

(1) $P(i,j) = f(1)(A(j)/D(i,j))/f2(U(j)/S(j))$

Equation 1 defines in some way the opportunity for people at origin i to use park j. An estimate of their opportunity to use all parks, called their "Opportunity Ratio", is given as:

(2) $OR(i) = @E\ (f(1)(A(j)/D(i,j)/F(2)(U(j)/S(j))$

WHERE the summation is on $j=1$, NP; and NP = the number of parks within some arbitrary distance of i (see TN 3) or the number of parks within the jurisdictional area to which the planning is related. This statistic gives a measure of the effective access which residents at i have to park recreation facilities, and can, of course, be calculated for all origins.

Given that exact forms of the functions f1 and f2 can be specified, numerical values of $OR(i)$ can be calculated and plotted on a map and used to indicate the extent of regional and local variation in access to park facilities. Such a map has value to planners considering locations for new parks. However, since these scores are dimensionless ratios, it facilitates reading of the map if these ratio scores are standardised around a convenient value; e.g. a mean score normalized to 10 or 100. Using the latter value for the mean enables an origin's percentage deviation from the study area's average value to be directly read from a map. Here such normalized quotients are referred to as Opportunity Quotients.

DISCUSSION

The usefulness of the quotient depends, of course, on the function in Equation 2 resembling reality in some sense or other and in the final analysis, the real level of outdoor recreation opportunity for any origin is what the people there perceive this level to be. The statistic, therefore, ought to have the same spatial pattern of variation as perceived recreation opportunity. The degree of correspondence between the two depends largely on two factors. Firstly, the general form of the functions in Equation 2, in particular, must be realistic, i.e. the variables in this equation must be the relevant ones and they must be combined in a fashion that corresponds to perceptual reality. Secondly, the weightings involved in f1 and f2 in Equation 2 must have empirical validity. This is not the place to enter into a discussion of how to ensure these requirements are satisfied. Nevertheless, the validity of the map of Opportunity Quotients depends on the above conditions being met.

AN ALTERNATIVE FORMULATION

The above discussion of the Opportunity Quotient has been based on the assumption that the competition for recreation resources is best measured at the recreation sites themselves, and that competition is a force which can "hold people away" from a potential site. This is the measure that is referred to as U(j) in Equation 2.

One can make an alternative assumption which treats the competition factor in a different sense. In this case, one assumes that the "pull" of resources is exerted at the point of residence of each individual, and that it is this force which draws one away from his home to seek recreation opportunities. Because there can be no simple measure of this competition, one must measure it through the use of a surrogate, here chosen to be the population potential. This statistic, long employed by geographers, distributes the "pressure" exerted by a population over space, usually in a negative exponential fashion.

The measurement of the outdoor recreation supply available at any point i is performed as indicated in Equation 2 above, except that the surrogate of park attractiveness, A(j), used here is the natural logarithm of park size (ln S(j)). The justification of this transformation is that the strength of a person's perception of the stimulus of park size is believed to be directly related to the natural logarithm of the park size rather than to the park size itself. (See TN 9 for references to the literature.) This transformation has the effect of giving relatively more weight to the smaller parks and playing down the importance of the larger ones.

Under these assumptions, an equation analogous to Equation 2 is written as:

$$(3)\quad OR(i) = \frac{\left(\Sigma \ln S(j) / D(i,j)^{d1} \right)}{\left(\Sigma P(k) / D(i,k)^{d2} \right)}$$

WHERE NK = the number of population centres within some arbitrary distance of a location (not necessarily a city - just a point in space); and the sums are for j=1,NK.

d1 and d2 = two constants, usually ranging between 1.0 and 2.5 but not necessarily equal;

and other terms are as previously defined.

One should note that this equation is for computing an CR(i) for any arbitrary location i based on the cities and parks that are located within range of i, regardless of whether or not anyone lives at location i.

It is not relevant to speak of this measure as indicating the response of "the people" at i to their facilities, but rather the ratio reflects how a person at i would "perceive" the availability of parks around him in comparison to the "degree" that he would recognize that there were people around him. The measure defined by Equation 2 has the more "straight forward" behavioural interpretation of indicating what the "effective" combined opportunities to participate at any location appear to be to a person at his given location i. The difference is subtle but important!

It should be noted that the interpoint distances (D(i,j), D(i,k)) utilized may be actual road distances (where available), Manhattan distances (or other Minkowski metrics), time distances or actual geographic distances. In this study the authors have utilized the latter. In the absence of firm knowledge about the values of d1 and d2 in Equation 3, the values of 1.0 have been used to develop a real map.

Obviously, the statistic defined by Equation 3 may be scaled in the same way as that defined by Equation 2, thus leading to a quotient representing a deviation from a known mean value.

A PRACTICAL EXAMPLE

The practical example discussed below was calculated and mapped for the Windsor-Quebec Urban Corridor project of Environment Canada's Lands Directorate (Lands Directorate, 1974). In this example the work was performed according to the assumptions outlined in Equation 3. The sole change was that the points for which the Opportunity Quotient was calculated were assigned double subscripts to facilitate calculation and mapping.

The data utilized in the project are (1) population statistics incorporating all communities larger than 1,000

OUTDOOR RECREATION OPPORTUNITY QUOTIENT
WINDSOR-QUÉBEC CITY AXIS

The height of this surface at any point ij is calculated as follows:

$$SP_{ij} = \sum_{k=1}^{N_k} \ln S_k \; D_{ijk}^{\,-a}$$

$$PP_{ij} = \sum_{l=1}^{N_l} P_l \; D_{ijl}^{\,-b}$$

$$OR_{ij} = SP_{ij} \; PP_{ij}^{\,-1}$$

$$ROQ_{ij} = (OR_{ij} \; \overline{OR}^{-1}) \, 100.0$$

Where: SP_{ij} = the supply potential at point ij,

$\ln S_k$ = the natural log of the area of the kth recreation site,

D_{ijk} = the distance separating point ij from recreation site k,

PP_{ij} = the population (demand) potential at point ij,

P_l = the population of population centre l,

$\overline{OR}$ = the mean of all OR_{ij},

D_{ijl} = the distance separating centre l from point ij,

N_k = the number of recreation sites,

N_l = the number of population centres, and

a and b = constants here set to 1.0.

Date Source
Canada, Department of Indian and Northern Affairs, 1969 Canada Outdoor Recreation Demand Study Facility Inventory, unpublished data.

Special acknowledgement is made to Dr. J.H. Ross and his assistants of the Outdoor Recreation-Open Space Division, and to the Resources Mapping Division Lands Directorate, for the preparation of this map.

population situated within 500 miles of each of the points for which a particular OR(i) is computed, and (2) the CORD Study Facility Inventory statistics on federally or provincially operated recreation sites (for details on these data see Volume III).

In order that the competition of American recreationists might be taken into effect, the population of each state was assigned to the state's capital, and this population taken into account if it met the distance constraint used. These population masses were then incorporated in the calculations. After calculation and scaling, the Opportunity Quotient was isoplethically mapped (see Figure 1).

The contours on the map join points at which OR(i)'s are equal: points at which people would perceive a constant ratio of the type described earlier in relation to Equation 3. Inspection of the map produced reveals two obvious patterns. The general influence of the American population lying to the south and west, which exerts great pressure over the study area, is most pronounced in the Windsor-Chatham area, and decreases in strength to the east and north. It is also evident in the Niagara Peninsula and south eastern Quebec. The influence of the population concentrations near Toronto and Montreal are revealed by the east-west extent of the poorly served areas adjacent to them, and by the alignment of the "ridges" of opportunity separating them. The generally high degree of opportunity evident across the northern portion of the map reflects both the lower population pressure and the greater supply of recreation land provided by such parks as Algonquin, Mont Tremblant, Papineau and Laurentides.

CONCLUSION

The measurement of an intangible such as one's opportunity to participate in outdoor recreation is extremely complex and is hampered by both practical and theoretical problems. (The problem alluded to here is the one for which a solution is sought in TN 29 and should not be confused with the inventory problem discussed in TN 16.) The practical problems largely relate to data collection costs, particularly if variables such as park attractiveness have to be estimated using behavioral data on park choice (see Chapter III for a discussion of various methods of estimating park attractiveness). The more serious problems are theoretical ones and centre around the problem of specifying a functional form for the Opportunity Quotient and of defining accurate estimates of its parameter values, such that there is a close correspondence between the value of the quotient and people's perceived recreation opportunity.

Two examples of alternative forms of the Opportunity Quotient based on rational argument have been suggested. Although only one has been mapped, it seem likely that there

would be significant differences between two maps based on different forms of the quotient. Therefore the final selection of appropriate formulae will require them to be validated against perceptual information on recreation opportunities. To compound problems, serious methodological problems exist in trying to measure such perceptions. However, without such validation, the real meaning of any Opportunity Quotient will remain in doubt.

CORD STUDY TECHNICAL NOTE 17

A METHOD OF ALLOCATION OF RECREATION SUPPLY TO URBAN CENTRES

W. Acar

(Introduction and Concluding Sections)

J. Beaman

ABSTRACT

In recent years, the Ontario Government has been increasingly concerned with providing the public with opportunities for outdoor recreation on an equitable basis. Thus, there was a need for a simple model which could detect the areas of potential overload in the Province's recreation supply system, given the past trends of population and existing and planned supply.

Because of a strong interest in short-trip recreation, it was proposed that an allocation model be developed to study the opportunities for day trips and weekend trips from any of Ontario's urban centres within K-hour travel zones of the centres - K being 2 hours for day-use and 3 hours for weekend trips.

It was decided, for evaluation purposes, that the only supply to be considered effectively available to an urban-centred region was the amount lying inside its k-hour travel zone; and that the populations of the various urban centres compete for the use of the same opportunities in those areas where the travel zones overlap. Competition for a particular unit of supply was hypothesized to be defined by the pressures that centres would exert on "the supply they potentially have" and by a function of the travel times to a region where a supply is located, for which these centres compete.

The paper presents the assumptions just stated and describes the computational procedures developed.

It describes the computer algorithm which was prepared to allocate the supply of recreation opportunities in each destination region to urban centres in a way which is consistent with the competition and other effects hypothesized. The algorithm allows the generation of a measure of the supply per capita effectively available to the residents of the differnt urban centres.

An example that can be computed manually is presented, as well as the general mathematics of the stimulation of the competition that takes place.

The computer programs developed have been tested

extensively. It is equally possible to use them to study the allocation of supply using as little as 7 origins in 12 destinations or for much larger problems (e.g., 25 by 156). However, details on the programs are not provided. The reader is referred to other sources for this material.

INTRODUCTION

The model described below was developed to answer a number of priority planning questions. These questions could not wait the completion of more sophisticated modelling efforts in which Ontario is also involved (see Reference 33 and 34). For example, one planning question is the issue of whether more publicly supplied recreation opportunities should be placed near Toronto or whether such facilities should be placed in other areas which appear to be deficient in opportunities for recreation activities of a given type.

A continuing emphasis in Ontario has been the setting of objectives for the Outdoor Recreation Program (see Reference 30). Given the proposed objectives of the Province, it was possible to visualize an allocation of facilities which embodied these objectives. One possible allocation evaluation scheme being considered by Ontario is defined by the model presented in this paper. This scheme, by allowing examination of the existing distribution of user-days potentially available to participants in an activity, is designed to reflect the level at which all people in the Province of Ontario who desire to participate have access to particular kinds of facilities.

Rationale

A basic premise in the model presented is that participation rates can be used to calculate the number of participants in an activity that an area "should" generate. "Should" is used here to mean that it is possible to calculate the number of participants an area would generate if it were supplied with facilities in a way that reflects a standard that would be acceptable for all areas of the Province. For example, the number of participants which "should" be generated could be based on a standard defined using differentials computed by the analysis of variance. (See TN 12.)

No matter what formula is employed to calculate the number of participants an area "should" generate if appropriately supplied by opportunities, the approach proposed is to see how the number of potential participants in an area is related to the available supply of facilities. Ultimately, the object of this analysis is to see what pressure achieving a certain "standard" of participation would put on facilities available to an area within a particular distance of it.

Of relevance to the objective, then, is the principle

of the K-hour travel zone. Because of interest in equity of opportunities for short-trip recreation, it is reasonable that only supply within two hours one-way travel from an urban centre be considered as available to that centre. In other words, for short-trip recreation, here it is considered that supply is "available" only if a destination is within two hours of an origin, one-way.

Given that K-hour travel zones are defined, allocation modelling would be simple if it were not for the fact that different urban centres compete for use of the same supply. Certain factors recognized as affecting park use are not considered in the allocation model. However, the works of Cheung (TN 1), Cesario (TN 4), Ross, et al. (TN 2 and TN 5), or Ellis and Kerr (Reference 33) do consider the effects of alternative facilities and/or attractivity of facilities on park use (see TN 1, TN 3, TN 4, TN 11, TN 33 and sources cited therein). Basically, in formulating an allocation model, it was considered wise to use a simplistic theory that did not attempt to consider elaborate interactions between supply units. A more complicated model might have resulted in more accurate results. But, the formulation of the allocation model had the immediate objective of supplying information to decision makers, as well as being a contribution to a growing literature on supply allocation models. The immediate needs for a decision-aiding model made it essential to place a limit on theoretical embellishments to the model.

Modelling Assumptions

One way to proceed to develop a model is to state assumptions and proceed to show how a model may be developed based on these. That is the approach taken here.

Assumption A1: The residents of an urban centre should not need to go beyond the K-Hour-Drive Isochrone (i.e., outside the K-Hour Travel Zone) to receive a given level of service for day-use participation in a given activity.

This assumption embodies the policy that there is an intention to provide facilities for certain activities at a certain level of service within a certain distance of most residents of the cities of Ontario. This assumption is an assertion that Ontario, by using the model, is investigating the implications of accepting the view that its citizens should not recognize the disutility of travelling up to two hours one way and that its citizens should recognize infinite disutility for travel any further than this basic distance. This statement, of course, only refers to travel for day-use participation. The Province may indicate a different number of hours of travel as allowable for different activities and for overnight use of an area for a given activity.

Assumption A2: The population is homogeneous, across the province, with respect to those socio-economic variables affecting recreation participation.

This assumption is made so that a simple approach may be taken to determining the number of participants that "should be" generated by an area. The analysis of variance approach to calculating participation, alluded to earlier, allows one to associate different "ideal" or "standard" participation rates with different ages, sexes, etc. But examination of participation in Saskatchewan, where a sophisticated formula was used to take into account the variation in socio-economic characteristics of the population in various cities, showed that only small differences, in the order of 10 percent at the largest, resulted from using this elaborate formulation rather than a simple participation rate. Given that one does not expect to be within 10 percent in this (or any) exploratory modelling effort, there is little merit in introducing such complexity into a model.

Assumption A3: The supply of "facilities" for the activity being considered is homogeneous with respect to quality.

This assumption is also designed to facilitate competition modelling. But it also has distinct policy implications. It is readily recognized that there are better and poorer hunting areas, better and poorer picnicking areas, and that the problem of assessing quality, or what some authors call attractivity (see TN 1, TN 2, TN 4 and TN 9), is a problem which is receiving substantial consideration. (See Reference 24.)

Basically, the theoretical concern is that some participants in an activity receive a higher benefit from going to a good facility than others receive from going to a poor facility. The homogeneity assumption simply says from a policy perspective that all facilities will be "recognized to be" as of equal utility for the activity of concern. Thus, if this assumption is used in a given analysis, one is choosing not to acknowledge the difference between facilities as long as they meet the Province's basic standards for the given activity. At this point, assumption A3 is required to allow one to carry out modelling, at least until accurate attractivity measures have been assessed and adequately verified will it become possible to use these factors (given that implications of their use remain consistent with policy) in stimulating the competition and resulting allocation.

Assumption A4: The concept of a "resistance to travel" may be used to define a function that indicates how areas, for which different population centres compete, should share the supply in destination units which they have in common.

This assumption is an interim approximation to reality accepted until some more appropriate approach can be taken. Basically, the general statement embodied in Assumption 4 is included here to serve as an introduction to a more detailed enunciation of a partition formula indicating how origins share supply units for which they compete this enunciation follows later in the text.

Assumption A5: It is possible to treat Southern Ontario as a limited number of supply units (destination units; e.g., 12 or 156) and a limited number of origin unit (e.g. 7 or 25).

The computational procedures that are defined in the discussion of the competition (and allocation) model involve dividing southern Ontario into origin and destination units. Supply is associated with destination units (clusters of townships), and population is associated with origins (cities and surrounding areas). This assumption embodies the idea that the population of southern Ontario is so highly concentrated in cities that for the purpose of calculating distance (and other manipulations that are described) populations may be considered to be concentrated at given points. It is also assumed that all the supply in a given unit is available at a point.

If one has dealt with problems where this kind of an approximation has been used, it will be realized that where population units are concentrated in cities this kind of an assumption works particularly well. Where the supply tends to be uniformly distributed within a supply unit and the distance functions do not tend to drop off in too much of a curvilinear manner over a supply unit, it may also be expected that the approximation does not result in problems. Thus, it may be understood that this assumption, as with other assumptions already stated, involves reasonable approximations to "reality" which are being made to operationalize a model that can be modified in later, more elaborate calculations.

Model Description

Consider counties, c, with a supply of facilities yielding up to A(c) opportunities. Let S(c,u,i) be the amount of A(c) allocated to a centre, u, in stage (iteration), i, of the allocation process. Also consider that the following two tables or matrices are specified: D(c,u) is an element of the array that gives distances from supply units c to a centre u. P(c,u) is an element of the array that gives the percent of the user-days of supply in c that is within the Z-hour travel zone of u.

Now it is claimed that an allocation consistent with the assumptions already given is achieved by the iterative procedure which follows. For each "i" (starting at i=0), one defines an equation for prorating supply in each c to each

u:

$$(1)\ PRO(c,u,i) = \frac{P(c,u)p(u,i)/f(D(c,u))}{\text{@E}P(c,u)p(u,i)/f(D(c,u))}$$

The sum in the denominator only serves to normalize the proration so that all the supply of c is associated with some u (so the sum of PRO(c,u,i) over u equals 1 for all c's). In the above p(u,i) is the pressure that a population places on the supply available to it: is the supply available per participant defined by:

$$(2)\ P(u,i) = \frac{\text{(population of u)*(Per Capita Participation Rate applied to all u's)}}{\text{@E } PRO(c,u,i)\ A(c)}$$

$$= \frac{\text{(population of u)*(Per Capita Participation Rate of all u's)}}{\text{@E } (c,u,i)}$$

WHERE the sumes are on c.

Where the sum in the denominator serves the same kind of normalization function as described for the denominator in Equation 1, it can be rewritten using POP(u) for the population term and PPR for the per capita participation rate (which it was stated could be used in Assumption A2) as:

$$(3)\qquad p(u,i) = POP(u) \times PPR/ \text{@E } (c)S(c,u,i)$$

Now, Equation 1 indicates that the proportion of the supply in c allocated to u is inversely proportional to some function of distance (or travel time, should times be stored in the D(c,u) matrix), so Assumption A4 has been built into the allocation. Inclusion of P(c,u) and p(u,i) in Equation 1 indicates that supply is prorated in direct proportions to these variables. So the supply in c is allocated to u in proportion to the amount of that supply included in each u's K-hour travel zone, conditional on the pressure that each population centre places on the supply available to it.

If all u's placed the same pressure on the supply available to them one can see that p(u,i) would cancel in Equation 1 resulting in:

$$(4)\ PRO(c,u,i) = \frac{P(c,u)/f(D(c,u))}{\text{@E } P(c,u)/f(D(c,u))}$$

which indicates that each u would receive a share of the supply in c that would reflect how much of c's supply was in u's k-hour travel zone and how far c was located from u in

comparison to c's distance from other u's.

At this point the reader will easily recognize that the kind of allocation being described is that discussed under Assumptions A1 and A4. The effect of distance on the use of facilities is recognized. But if the population per unit of supply is high, the pressure on facilities is high for some u; this u has "priority" compared to low pressure u's being allocated supply for which there is competition. However, it may also be recognized that to calculate the PRO (c,u,i)'s, it is necessary to know the p(u,i)'s (the pressures) and vice-versa. But one does not know either. Still, one can say that an initial estimate of the pressures can be obtained by assuming that all u's get all supply within their K-hour travel zone. So according to Equation 3:

$$(5)\ p(u,o) = \frac{POP(u) \times PPR}{@E\ A(c) \times P(c,u)}$$

where the PRO(c,u,i)'s have been set to 1 reflecting the approximation described above.

Now, the zero value of the subscript i in p(u,0) indicates that the values defined by Equation 5 are initial estimates of the p(u,i)'s. If these are substituted into Equation 1, one may write the equation for the first iteration:

$$(6)\ PRO(c,u,1) = \frac{(P(c,u) \times p(u,o)/f(D(c,u))}{@E\ P(c,u)/f(D(c,u))}$$

Thus one gets estimates of the PRO(c,u,1) and these may be substituted into Equation 3 to get revised estimates of the p(u,1) which can be substituted into Equation 1 to get revised estimates of the PRO(c,u,2). This procedure can obviously be repeated indefinitely with each cycle of computation, i, being called an iteration and resulting in values that can be used in the (i + 1)th iteration:

$$(7)\ p(u,i+1) = \frac{POP(u) \times PPR}{@E\ PRO(c,u,i)A(c)} = \frac{POP(u) \times PPR}{@E\ S(c,u,i)}$$

WHERE the sums are on c.

$$(8)\ PRO(c,u,i + 1) = (P(c,u)p(u,i + 1))/f(D(c,u))/SS(u)$$

So, Equations 7 and 8 are the basic computational equations for the allocation. The aim is by repeated application, to move from the approximation originally made to the equilibrium values PRO(c,u,*)'s and p(u,*)'s that are no longer approximations but actually give the population pressure on facilities that results when the supply in each c has been properly allocated. These pressures indicated by p(u,*) then provide information to planners or managers

about the relative deprivation of some areas compared to others. Of course, the above formulas can be written by replacing (i) or (i + 1) by the number (*) of the equilibrium or final iteration.

A manager, by looking at a series of pressure values, say 7, 5, 4.5, 4.4, 4, 3.8, 3.7, could conclude that there was a definite need to put in facilities to increase the opportunities to the area with a pressure of 7. The manager may, however, wish to have the allocation program run a number of times with different alternative development plans to see which results in the most desirable pressure values or which ones results in an acceptable set of pressures at a minimum cost. Incidentally, such runs would be made using projected population so that the solutions (pressures) arrived at would be appropriate to the time when facilities were actually in place.

An Example

Some readers may find the preceding easier to follow if given an example. So before going on to cover some special points, consider two urban centres A and B with populations 100,000 and 50,000 respectively. Assume that these centres are served by three supply areas each offering 1,000,000 user-days of activity in the way indicated in Table 1. Also for the sake of simplicity assume D2 ±B = 2D2 ±A and for convenience use MUD to indicate millions of user-days (1,500,000 user-days = 1.5 MUD).

As described earlier, to begin allocation one allocates to both A and B all supply that they could possibly have a claim to: (1) is entirely allocated to A, (3) to B, and (2) is allocated 100% to A and 50% to B (is over allocated). So assuming PPR = 1, initial pressure estimates are:

p(A,0) = 100,000/2000 = 50.00

p(B,0) = 50,000/1500 = 33.33

and substituting these into Equation 1 (or using Equation 8)

PRO(A,2,0) = 50.00/(50.00 + 8.33) = .857

PRO(B,2,0) = 8.33/(50.00 + 8.33) = .143

The other PRO(, ,)'s need not be calculated because the way the example was set up they are equal to one or zero depending on which u the supply being considered has been totally allocated to.

Now, proceeding to iteration one using the initial values that have been establised and using Equations 7 and 8 one finds for iteration 1:

TABLE 1

PERCENT OF SUPPLY IN THREE REGIONS
INCLUDED IN THE K-HOUR TRAVEL ZONES
OF TWO CITIES

		Supply Areas 1	2	3
Cities	A	100	100	0
	B	0	50	100

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$$p(A,1) = 100.000/1000(1 + .857) = 53.85$$

$$p(B,1) = 50,000/1000(1 + .143) = 10.94$$

$$PRO(A,2,1) = 53.85/(53.85 + 10.94) = .831$$

$$PRO(B,2,1) = 10.94/(53.85 + 10.94) = .169$$

Carrying out a second, third, etc. iteration does not change the pressures much. About 1.83 MUD are allocated to A and 1.17 to B meaning, in the general sense, that the pressure on the supply of A is about 5 times as high as on the supply allocated to B.

When, by using the allocation approach, it has been found that there is a 5 to 1 pressure differential, the question is: So what? If the area with high pressure is still adequately supplied with facilities according to some standard then no action is required. If it is not, then as suggested elsewhere in this paper, other supply may be introduced into the system in any number of ways and the resulting allocations tested. However, in this case it is obvious that to lower the pressure at A without also lowering B one should add to supply area 1. Still, if supply area 1 is near urban land it may be cheaper to add sites to area 2 (if land there is cheaper.)

Technical Points About Improvements to and Possible Modifications to the Model Defined

The preceding discussion has not pursued a number of points of importance in actually using the model on problems less trivial than the example. And rather than pursuing details further here the reader is asked to note that the

program and data listing can be obtained. Inquiries about the listing or about making runs using the algorithm should be directed to:

Supply Allocation Recreation Analyst,
Policy Coordination Secretariat,
Room 6508 Whitney Block,
Queen's Park,
Toronto, Ontario.

The Ontario Ministry of Natural Resources is interested in learning about potential users of the algorithm and in assisting users in solving problems associated with use of the model.

The kind of issues that arise in actually using the model are numerous. A few of the important ones which the reader may wish to note are: (1) a "convergence criterion" must be specified so that iterations can be stopped when a solution is good enough. For this and other technical matters (e.g. the necessity of intra-iterational loops, etc.), see Reference 1. (2) By merely calculating allocation based on the factors in Equation 1 and 3, there is no guarantee that some areas will not be above their saturation limit, in terms of some standard of a maximum number of persons per unit of recreation supply. Correcting for this involves reallocating users in a way consistent with the general procedure. Whenever the "load" of any one c is larger than allowed, then the additional people can be "chanelled" to other c's. (For further information on this point, see Reference 1, 33, and 34.) (3) A distance function must be chosen.

Regarding the latter, it should be noted that sensitivity to change in the distance function is relevant in considering resistance of distance as an impediment to travel. Runs of the allocation model have been made that use different distance functions. These runs have produced measures of allocation with only minor differences. Thus, the model has been found to be only mildly sensitive to different distance functions. This mild sensitivity can be understood by noting the similarity of a variety of functions of distance over a broad range of distances (see Figure 1 of TN 14, and Reference 34).

CONCLUSION

The method of stating assumptions that define a model that is used to aid analysis of a planning problem has not gained wide acceptance in planning outside of highly quantitative planning circles. However, if it is recognized that in this paper the object of defining a simulation model is to use it to generate a measure of goodness of allocation of the supply of facilities for participating in an activity, then the merits of the exercise may be clearer.

Care should be taken not to reject this approach

because of objections to some modelling assumptions. The assumptions postulated do not necessarily define a behavioural system, but rather a method of measuring allocation that is consistent with the proposed objectives of Ontario. It must be recognized that whether or not people behave in a certain way is not fundamentally the point at issue; assumptions that reflect objectives or policy should not be confused with behavioural assumptions.

A method of deriving a useful measure of pressure of recreation supply has been defined. There is a need to be concerned about how assumptions used in deriving the measure may be interpreted. If this simulation of competition is an appropriate yardstick against which Ontario may measure the opportunities it provides to different groups of its citizens, it is imperative that the user understand that yardstick. Accepting the model may result in accepting a supply of opportunities at a certain level as good, whether or not people use these opportunities. (That the opportunities or facilities are under or over used when an allocation is good may only reflect the fact that people do not behave as if travel up to K-hours has no disutility.)

The relevance of policy and its dominance over behavioural considerations in this formulation is brought out clearly when one reviews the development of the model's definition. An arbitrary time of driving, namely two or three hours, is accepted as having no disutility. No particular weights that degrade a visit are introduced to suggest that current policy might value opportunities at one-hour distance over service near the desirable limit of travel. On the other hand, examination of the supply framework used here (see TN 16) shows that the Province of Ontario is seriously considering a policy that takes into account the standard work week and degrades supply that is primarily available only during the work week. The model is more a policy planning model than a model for predicting. But it is a quite acceptable policy planning tool, given the state of the art in outdoor recreation planning and the equalitarian objectives of Canadian governments.

SENSITIVITY ANALYSIS OF LAND USE ALLOCATION MODEL

H. K. Cheung and J. Auger

ABSTRACT

It has become increasingly apparent that the sensitivity of linear programming parameters defining a given allocation problem is a weakness of the approach. This paper presents the results of a sensitivity analysis performed on a linear programming land use allocation model. In the problem treated the objective function, defined as the total profit received from single or multiple use of four hypothetical forestry lands, is first maximized. Then parametric programming is used to investigate the effect of coefficient changes on the optimal solution.

The utility of having a set of alternatives in a planning perspective is emphasized throughout. In particular, the example pursued points out the following considerations about the solution that was initially found:

1. A shift from multiple use to single use results if there is a 3 percent change in one of the profit coefficients.

2. No great loss in total profit results if a certain activity not in the basis is introduced.

3. A small change in the opportunity costs used to determine the price for using a unit of an outdoor recreation activity causes a change of policy.

INTRODUCTION

Over the years a steady increase in the use of our natural resources for recreation purposes has resulted in a large amount of literature dealing with estimating use, and valuing benefits, of outdoor recreation sites. Many of the quantitative techniques used to estimate recreation use and analyse outdoor recreation data in general have been drawn from the realm of statistics. These include regresssion analysis, factor analysis, analysis of variance, cluster analysis, and other multivariate methods.

Relatively recently, an optimization technique, linear programming, has been applied to analyse outdoor recreation data. Meir (see Reference 48) developed a linear programming

model which incorporates in a mathematical framework many of the factors relevant to the planning of recreation land acquisition expenditures. Tadros and Kalter (see Reference 58) worked out a spatial allocation model for projecting outdoor recreation demand which takes the form of a linear programming solution. Manning (see Reference 46) dealt with multiple use of forest land in a linear programming context. Saitta and Schmedemann (see Reference 54) used linear programming to maximize the number of new visitors to a park on a peak weekend. However, none of these papers dealt with a very important aspect of linear programming, which is sensitivity analysis of the input coefficients used.

So, it is the purpose of the present paper to report on the results of a sensitivity analysis performed on a modification of Manning's allocation multiple use model.

It should be recognized that once a solution to a linear programming problem has been determined, the cost of sensitivity analysis compared to the cost of finding the solution is usually small.

A LAND USE ALLOCATION MODEL

Consider four pieces of forest land, each of which can be used for one or more different purposes: (1) timber production, (2) agricultural production, (3) recreation, and (4) multiple use. The assumptions concerning the use of the lands are: (1) the lands are already in public ownership, and (2) multiple uses (recreation and forestry use) are compatible.

Information that is known about the lands and various products is as follows:

(1) The production capabilities (Table 1).

(2) The resource availability for production (Table 2).

(3) The prices of agricultural and forestry products (Table 3).

(4) The prices, as derived by using opportunity cost of recreation products (Table 4) as defined by Equations (A.2) – (A.4) in the Appendix.

(5) The resource requirements of each activity (Table 5).

The objective is to determine the production levels of the activities (uses) within the limitations of the resources, such that total profit is a maximum.

Utilizing the information presented in Tables 2 and 5, one can formulate the linear programming problem as follows:

Maximize CX

subject to $AX \leq b$, $X(j) \geq 0$; $j=1,16$

WHERE C = The profit coefficient vector as defined in the ninth column of Table 5.

X = The activity vector as defined in the first column of Table 5.

A = The activity coefficient matrix as defined in the fifth and sixth columns of Table 5.

b = The requirement vector as defined in Table 2.

The problem formulated above was solved by the Simplex method (see Reference 26). The solution and the levels of resources used are summarized in Table 6. The maximum total profit obtained is $3,462 per annum. The policy that effects this maximum total profit is to utilize all 80 acres of land B for white spruce production and camping; all 268 acres of land C for wheat production; 1042 acres of land D for poplar production and hunting, and not to use land A at all.

TABLE 1

PRODUCTION CAPABILITIES PER YEAR, PER ACRE OF FOUR HYPOTHETICAL LANDS*

Use		Production of Land A	B	C	D
Timber	White Spruce	0.56	0.40	0.70	-
	Poplar	-	-	-	1.00
Agriculture	Barley	7.00	-	-	-
	Potato	-	105.00	-	70.00
	Wheat	-	-	20.00	-
Recreation	Hunting	11.00	-	-	3.00
	Camping	-	60.00	-	-
	Fishing	-	-	81.00	-
Multiple-Use	White Spruce	0.56	0.12	0.70	-
	Poplar	-	-	-	1.00
	Hunting	11.00	-	-	3.00
	Camping	-	20.00	-	-
	Fishing	-	-	81.00	-

* These production capabilities were determined using the Canada Land Inventory method. Timber products are measured in cords, agricultural products in bushels except potato, which is measured in hundred-weights, and recreation "products" in visitor-days.

\- zero production.

TABLE 2

RESOURCE AVAILABILITY FOR PRODUCTION OF THE FOUR HYPOTHETICAL LANDS

Resources	Limits on Resources
Capital	$7,000.00
Labour	700.00 man-days
Land A	300.00 acres
Land B	80.00 acres
Land C	268.00 acres
Land D	1,046.00 acres

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TABLE 3

MARKET PRICES OF TIMBER AND AGRICULTURAL PRODUCTS

Product	Price
White Spruce	\$5.60 / cord
Poplar	\$1.34 / cord
Barley	\$1.15 / bushel
Wheat	\$1.25 / bushel
Potato	\$1.25 / hundred-weight

Sources: (1) G. Manning op. cit. (1971)

(2) New Brunswick Department of Agriculture and Rural Development, AGRICULTURAL STATISTICS, 1971, Fredericton, New Brunswick.

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TABLE 4

OPPORTUNITY COSTS FOR RECREATION USE OR MULTIPLE-USES OF THE FOUR HYPOTHETICAL LANDS

Land	Use	Opportunity Cost, \$
A	Hunting	0.47
	White spruce and hunting	0.36
B	Camping	2.17
	White spruce and camping	1.56
C	Fishing	0.26
	White spruce and fishing	0.06
D	Hunting	4.95
	Poplar and hunting	4.30

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TABLE 5

GROSS RETURN, TOTAL COST AND PROFIT OF PRODUCTION PER ACTIVITY PER ACRE OF THE FOUR HYPOTHETICAL LANDS

Land	Activity acre	Product	Gross Return(1),$	Capital Cost(2),$
A	X1	White Spruce	3.14	3.00
	X2	Barley	8.05	12.00
	X3	Hunting	5.14	3.00
	X4	Multiple-Use:		
		White Spruce		1.00
			7.14	
		Hunting		2.00
B	X5	White Spruce	2.24	1.00
	X6	Potato	131.25	175.00
	X7	Camping	130.20	30.00
	X8	Multiple-Use:		
		White Spruce		0.20
			31.84	
		Camping		10.00
C	X9	White Spruce	3.92	3.00
	X10	Wheat	25.00	10.00
	X11	Fishing	21.00	1.00
	X12	Multiple-Use:		
		White Spruce		2.00
			8.92	
		Fishing		1.00
D	X13	Poplar	1.34	0.50
	X14	Potato	87.50	175.00
	X15	Hunting	14.84	3.00
	X16	Multiple-Use:		
		Poplar		0.10
			14.34	
		Hunting		3.00

(...continued)

TABLE 5 (contd)

Land	Activity acre	Labour (2) Man-Days	Cost,$	Total Cost(3),$	Profit(4),$
A	X1	0.10	2.00	5.00	- 1.86
	X2	0.30	6.00	18.00	- 9.95
	X3	0.20	4.00	7.00	- 1.86
	X4				
		0.10	2.00		
				7.00	0.14
		0.10	2.00		
B	X5	0.05	1.00	2.00	0.24
	X6	1.50	30.00	205.00	-73.75
	X7	5.00	100.00	130.00	0.20
	X8				
		0.01	0.20		
				30.40	1.44
		1.00	20.00		
C	X9	0.25	5.00	8.00	- 4.08
	X10	0.25	5.00	15.00	10.00
	X11	0.50	10.00	11.00	10.00
	X12				
		0.10	2.00		
				9.00	- 0.08
		0.20	4.00		
D	X13	0.05	1.00	1.50	- 0.16
	X14	0.25	5.00	180.00	-92.50
	X15	0.60	12.00	15.00	- 0.16
	X16				
		0.30	0.60		
				13.70	0.64
		0.50	10.00		

(1) The gross return per activity per acre is equal to the unit value of the product (as given in Table 3 and Table 4) multiplied by the quantity of the product per acre (as given in Table 1).

(2) The capital cost per acre and the labour cost per man-day are believed to be "reasonable" estimates. However, when a real situation is dealt with, people knowledgeable in these fields should be consulted in order to make the estimates as realistic as possible. The labour cost was calculated at $20. per man-day.

(3) The total cost is the sum of capital cost and labour cost.

(4) The profit is equal to the gross return minus the total cost per activity per acre.

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TABLE 6

LEVELS OF ACTIVITIES AND CONSTRAINTS
AT OPTIMAL SOLUTION

	Activity	Level	Constraint	Level
X8	White spruce production & camping land B	80 acres	Capital	$6,374
			labour	700 man-days
			land A	0 acres
X10	Wheat production land C	268 acres	land B	80 acres
			land C	268 acres
	land D	1042 acres		
X16	poplar production & hunting land D	1042 acres		

Total Profit = $3,462.00

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SENSITIVITY ANALYSIS - GENERAL CONSIDERATIONS

Clearly, the optimum values of the variables obtained using linear programming are dependent upon the coefficients used in specifying a given problem. In general a change in one or more of the coefficients will affect the optimum outcome significantly. One should note that the coefficients used to define a problem nearly always vary over time. For instance, the price of white spruce being $5.60 per cord this year may change significantly next year. Secondly, the coefficients are seldom known with complete certainty; in some cases they are only approximations of what actually happens in the real world. An example of imprecise coefficients definition in the model presented in this paper is those profit coefficients which were derived from using opportunity cost as a surrogate price for outdoor recreation products. They are inaccurate because they are estimated. It should be noted also that, depending on the type of data used, models are sometimes found to be quite insensitive to changes in coefficients. By discovering such insensitive regions, one can save a lot of time and expense by using approximate figures rather than precise figures obtained through extensive studies. Still, unless all coefficients used in an application are known exactly or the sensitivity of a model and coefficient change is known to be small, it

is important to investigate the effect on the optimal solution of coefficients taking on different values than the values used to obtain the initial solution.

To study the effect of different coefficient changes on the optimal solution, several variational procedures can be used. These are: (1) varying the objective junction coefficients, also called profit coefficients in this paper, (2) varying the requirement coefficients, (3) varying the activity coefficients and (4) varying simultaneously the profit and requirement coefficients. Only procedures (1) and (2) were used in this study. The use of these two procedures was considered sufficient for illustrative purposes.

The range of values that a profit coefficient can assume without involving a policy change when the other coefficient are held constant is presented in Table 7. One can see that if the profit coefficient of activity X8 (multiple use of land B) drops to $1.39 per acre, representing a change of about 3 percent, the optimum policy would be different X8 would leave the basis and X5, using land B for white spruce production, would enter into the basis). If, indeed, the amount of uncertainty involved in estimating this coefficient is more than 3 percent, the computed or estimated optimum policy may not be the "true" optimum.

Certainly the range information provides useful data to the decision maker. For example, it indicates whether an existing policy should be altered if there is a change in market price or capital and labour costs. From a management point of view, however, the most useful interpretation of the range information is the clear definition of the alternative with which acceptable profit coefficients are associated. In particular, Krutilla (see Reference 35), among others, has emphasized the "value" of not cutting off future options. In this regard, one should see which alternative is associated with a change in profit coefficient that cuts off the fewest future options.

Along a similar line, if a linear programming solution suggests moves from forestry to agriculture involving major capital expenditures which are not considered in the model, as well as a lack of flexibility in returning to forestry, one should be wary of the optimal solution. This is particularly true if sensitivity analysis suggests that other alternatives may be pursued with nearly equal profitability. Alternatively, one could introduce into the model costs of moving to agriculture and determine a more appropriate optimal solution.

The capital expenditure needed to achieve a near optimal situation may be small and much higher to achieve an optimum so that the best solution in a linear programming sense based on a single project perspective may be poor in a broader cost-benefit or PPB framework. (See Reference 26.) To expand on this point, a project can be considered in isolation or as a component of a system in which there are many priorities and goals. If a goal is to employ people, moving from an optimal linear programming solution which is

TABLE 7

THE RANGE OF VALUES A PROFIT COEFFICIENT CAN ASSUME, WHILE ALL OTHER COEFFICIENTS ARE HELD CONSTANT, WITHOUT INVOLVING A CHANGE OF BASIS

Activity, acre	Lower Limit, $	Original Value, $	Upper Limit, $
X1	•	- 1.86	0.12
X2	•	- 9.95	0.36
X3	•	- 1.86	0.24
X4	•	0.14	0.24
X5	•	0.24	0.28
X6	•	-73.75	2.03
X7	•	0.20	6.25
X8	1.39	1.44	infinity
X9	•	- 4.08	10.00
X10	9.69	10.00	infinity
X11	•	10.00	10.30
X12	•	- 0.08	10.06
X13	•	- 0.16	0.06
X14	•	-92.50	0.30
X15	•	- 0.16	0.72
X16	0.37	0.64	0.66

• = minus infinity

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not labour-intensive to a near optimal solution which is labour-intensive may make excellent sense from a systems point of view.

Basically, the discussion presented above suggests that linear programming is only valuable when used as a management aid (as opposed to an automated way of making decisions). Of critical importance in using linear programming is the ability of the manager to see that linear programming results are interpreted in the context of (1) alternative solutions, (2) alternative strategies that are politically and socially acceptable in the short term, and (3) the relative ease of moving to a given solution and how irreversible this move is.

SENSITIVITY ANALYSIS - THE EXAMPLE

As already noted, in the sensitivity analysis carried out, profit coefficients were allowed to vary. The lower limits of some profit coefficients were allowed to go to

minus infinity since none of the activities corresponding to these coefficients was in the optimum solution. On the other hand, the fact that the upper limit of the profit coefficient of activity X8 (multiple use of land B) is at plus infinity suggests that any increase in this profit coefficient will not effect a shift of policy, so long as the other coefficients are held constant. The upper limit of activity X10 can be similarly interpreted.

Sometimes one may want to know what it would cost to produce a unit of a non-basic activity, without causing any activity to leave the basis. For instance, using one acre of land A for white spruce production and hunting (activity X4) would decrease the total profit by $0.10 (Table 8). This would also have the effect of increasing the capital used by $1.83 and decreasing the use of land D for poplar production and hunting (activity X16) by 0.38 acres, while activities X8 and X10 would be unaffected. The maximum number of acres that can be used to carry out activity X4, without causing any activity to leave the basis, is 145. If all of these 145 acres of land A were used for activity X4, then total profit would decrease by $14.50 and the capital slack would be used up. Thus, in view of the small loss in total profit, it may be a "good" policy to use land A for multiple-use rather than to leave it completely idle.

Another type of very useful information that can be gained from a post optimal analysis of linear programming solution is that gained by varying those requirement coefficients which are used at their limit levels. If it is recalled that for the current optimal solution (Table 6) all 700 man-days of labour, 80 acres of land B and 268 acres of land C were used up, it may be interesting to investigate the effect on total profit, the basic activities and the other constraints if these three requirement coefficients were allowed to relax one at a time. It is seen (Table 9) that an increase in one man-day of labour increases the total profit by $1.20 and the capital used by $5.85. The $1.20 increase in total profit is the result of increasing the use of land D by 1.89 acres for poplar production and hunting (X16). It is also seen that the increase in one man-day of labour has no effect on activities X8 and X10. On the other hand, a decrease of one man-day of labour would decrease total profit by $1.20, capital used by $5.80, land D used by 1.89 acres, while activities X8 and X10 remain unaffected. The range of validity over which the labour constraint can be changed without causing a change of basis is 147-702 man-days. Since the original allocation of labour, 700 man-days, was entirely used up in the current optimal solution, it means that no more than two man-days can be added if the current policy of carrying out the activities X8, X10, and X16 is to be kept. However, it is possible to decrease the number of man-days by 553. Similar interpretations can be given to a unit change of the requirement coefficients of land B and land C.

The increased (or decreased) profit as a result of changing the coefficient of a constraint at its limit level

TABLE 8

THE EFFECT ON TOTAL PROFIT; CONSTRAINTS AT LIMIT LEVELS;
AND THE BASIC VARIABLES -
OF FORCING A UNIT OF A NON-BASIC VARIABLE
INTO THE OPTIMAL BASIS

Activity acre	Profit $	Capital $	X8 acre	X10 acre	X16 acre	extent of substitution
X1	-1.98	2.42	*	*	-0.19	110
X2	-10.31	10.25	*	*	-0.57	26
X3	-2.10	1.83	*	*	-0.38	145
X4	-0.10	1.83	*	*	-0.38	145
X5	-0.04	-3.68	-1	*	1.81	2
X6	-75.78	161.83	-1	*	-0.92	1
X7	-6.05	-3.64	-1	*	-7.53	79
X9	-14.08	-7.00	*	-1	*	267
X11	-0.30	-10.46	*	-1	-0.47	267
X12	-10.14	-7.29	*	-1	-0.09	267
X13	-0.22	0.21	*	*	-0.09	4
X14	-92.80	173.54	*	*	-0.47	1
X15	-0.88	-0.51	*	*	-1.13	120

* = no effect

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is called marginal value. Like reduced profit, marginal value is valid only for changing one coefficient at a time within a specified range while keeping the other coefficients constant.

All of the variational procedures discussed so far involved changing one coefficient at a time. Furthermore, the change of the coefficient does not cause a change of basis. However, one can also gain insight into a linear programming solution by varying several coefficients simultaneously. Such a technique is called parametric programming. (For a practical application see Reference 26.)

Of particular interest is the simultaneous variation of those profit coefficients determined by using opportunity cost (see Equation A.1 in the Appendix). Here one wants to ascertain the stability of this formula and thus obtain an indication of how essential is accuracy in estimating the different coefficients of production.

Given that the basis changed as the result of a small change of the profit coefficients of X3, X4, X7, X8, X11, X12, X15 and X16 (Table 10), it is obvious that the model is

TABLE 9

THE EFFECT OF A UNIT OF CHANGE
OF A CONSTRAINT AT LIMIT LEVEL ON
TOTAL PROFIT, THE POLICY VARIABLES, AND OTHER CONSTRAINTS

	Labour, man-day	Land B, acre	Land C, acre
Profit, $	1.20	0.22	9.69
Capital, $	5.85	4.39	8.54
Land A, acre	*	*	*
Land D, acre	1.89	-1.90	-0.47
X8, acre	*	1.00	*
X10, acre	*	*	1.00
X16, acre	1.89	-1.90	-0.47
Range of substitution	(147,702)	(77,140)	(259,299)

* = No effect

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TABLE 10

THE CHANGE OF BASIS CORRESPONDING TO A SIMULTANEOUS CHANGE
OF THE OPPORTUNITY COSTS ASSOCIATED WITH
RECREATION AND MULTIPLE-USE ACTIVITIES

Change in Opportunity Costs, %	Resulting Optimal Basis*	Total Profit $
1.88	(X8, X11, X16)	3,742.70
58.83	(X8, X11, X15)	14,881.60
-4.60	(X5, X10)	2,699.20

* The original optimal basis was (X8, X10, X16).

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sensitive to small changes in opportunity costs. This suggests that the opportunity cost formula should be used with extreme caution. From Table 10, one also sees that when the profit coefficients change simultaneously by a mere 1.88 percent, it becomes more profitable to use land C for fishing than for the production of wheat. The new policy as a result of the change of the profit coefficients is using land B for white spruce and camping, land C for fishing, and land D for poplar and hunting. The increase in profit under the new policy is $280.70. This policy remains "optimal" until the same profit coefficients mentioned before change by 59.83 percent, when it is found more profitable to use land D for hunting alone than for multiple use. The result of a decrease in the profit coefficients determined by using opportunity cost can be similarly interpreted.

CONCLUSION

In this paper linear programming was applied to the optimal allocation of publicly owned forestry land among different uses, some of which, such as recreation, do not have established market value. The determination of a price that should be charged the users of an outdoor recreation facility was achieved through the use of the opportunity cost concept (see the Appendix).

However, the main objective of the study was to stress the importance and usefulness of carrying out a sensitivity analysis on the input coefficients after a linear programming solution is obtained. It was emphasized that sensitivity analysis is an essential part of a linear programming application for technical reasons such as: (1) the input coefficients specified in a given problem often change (2) the input coefficients are not always exactly known, and (3) resources, such as time and money, can be saved by discovering insensitive coefficients.

Reference was also made to the specific procedures that one can employ to perform a sensitivity analysis on the input coefficients. Sensitivity analysis can provide very useful data to a decision maker on what alternative courses of action are viable and possibly better than the optimum linear progressing solution in terms of (a)preserving future options; (b) making good sense in terms of social objectives; (c) being a better solution from a systems perspective; and so on.

APPENDIX

OPPORTUNITY COST

The opportunity cost method was used to determine the price that should be charged users for the use of the land for recreation. The opportunity cost used is the value of the alternative product which would yield the maximum profit.

$$(A.1)\quad P = \frac{(A(1)Y(1)P(1))-(A(2)Y'(1)P(1))-(A(3)(C(1)+C(2))}{Y(2)}$$

WHERE P(2) = the price, in dollars, of one unit of a recreational product.

P(1) = the price, in dollars, of one unit of a forestry or agricultural product.

Y(2) = the total number of units of a recreation product.

Y(1) = the total number of units of a forestry or agricultural product.

Y'(1)= the number of units of a forestry product in multiple use.

C(1) = maintenance and upkeep cost of forestry or agricultural production per acre.

C(2) = maintenance and upkeep cost of recreation per acre.

A(1), A(2), A(3) = constants having the value of zero or unity.

Equation A.1 is a general equation. Depending upon whether a piece of land is used for a unique product or multiple use, three cases arise which are described below:

(a) Recreation use alone (A(1) = A(3) = A(2) = 0).

In this case a piece of land is used entirely for recreation and Equation A.1 becomes:

$$(A.2)\quad P(2) = \frac{(Y(1)P(1) - C(1)) + C(2)}{Y(2)}$$

Basically, Equation A.2 shows that the opportunity cost of using a piece of land for one unit of recreation is equal to the sum of the profit that could have been obtained if the

land had been used for agricultural or forest products plus the cost of maintaining the land for recreation use, all divided by the quantity of the recreation product.

(b) Recreation use in part (A(1) = A(2) = A(3) = 1).

In this case, a part of a piece of land is used for recreation, the other part for forest production. Thus, Equation A.1 becomes:

$$\text{(A.3)}\quad P(2) = \frac{Y(1)P(1) - Y'(1)P(1) - C(1) + C(2)}{Y(2)}$$

The expression Y(1)P(1) - Y'(1)P(1) in Equation A.3 represents that portion of the revenue foregone when only part of a piece of land is used for recreation.

(c) Double use (A(1) = A(2) = A(3) = 0).

Finally, a piece of land is utilized for recreation and forestry at the same time. Nothing is really foregone here, for the land is used for one production as much as for the other. The price of recreation is assumed to be equal(at leas(to the cost of upkeeping the land for recreation. Thus, one obtains:

$$\text{(A.4)}\quad P(2) = C(2) / Y(2)$$

Equation A.4 implies that in multiple use involving hunting or fishing, forest productivity is not diminished. This notion has also been displayed by Pichette and Potvin (see Reference 52) who, in one of their studies concerning multiple use, suggested: "It is not unreasonable to say that good forest exploitation aimed at ensuring a maximum sustained production, abundant regeneration and improved planning also promotes increased production of fauna by appropriate environmental conditions".

The use of Equations A.2, A.3, and A.4 undoubtedly requires a good knowledge of the physical capacity, productivity and cost of production of a piece of land for every possible use.

There are advantages as well as disadvantages in using opportunity cost to determine the price of outdoor recreation products. The advantages are that one would be working with timber or agricultural products for which market values are generally well established. Also, the method is relatively simple to use. An additional advantage is that it enables a decision maker to see if the cost of providing certain outdoor recreation facilities is excessively high. A disadvantage is that it only permits the definition of a minimum price for outdoor recreation products. It does not tell us anything about the(valu(of the recreation product as perceived by the consumer. (See TN 31 and TN 38, plus references cited there.)

AN INTEGRATED APPROACH TO MULTI-DIMENSIONAL EVALUATION AND COST-EFFECTIVENESS ANALYSIS

Based on a paper by
W. Acar[1]

ABSTRACT

This paper shows how to integrate cost-effectiveness analysis with multi-dimensional evaluation techniques for use at the operational level in government agencies. It is concerned with a procedure that can be utilized when only one of several projects is to be the recipient of funds.

Emphasis is on making effective use of the decision maker's intuition to disaggregate decisions. The aim is to consider all the different factors that should influence a decision while utilizing a framework that helps to ensure that different factors affecting the final decision are given the "right weight". The framework for project evaluation is a collection of rules that guide one in defining scores, selecting factors for consideration, etc. by using intuition more effectively than is possible when traditional scoring procedures are used.

The method proposed offers a means through which the decision maker can control the amount of influence that intangibles have on a decision when compared to particular economically measurable factors.

An example is given to show how the integrated approach can be used.

INTRODUCTION

If people are going to make judgements, it is imperative to take all possible steps to see that insight and intuition are used effectively.

Yet, given the topic of the article, it is easy for an academic to see little value in it. He might criticize the "mathematics" or the psychological conceptualization as naive. But the real question is: Does the article present an approach that allows a manager to make better decisions?

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1. This version of TN 25 is based on an original paper prepared for for the 1973 meeting of the Canadian Association of Administrative Sciences (to be published in PUBLIC FINANCE). This edited text for Volume II was revised by J. Beaman and L. Belfry.

Suggestions that propose that one should do research for five years to make a decision that must be made this day or this week are not acceptable. Suggestions of spending $5,000 on studies to select alternative ways to spend $10,000 would also be unacceptable. These points deserve serious consideration before this article is criticized. Actually, the best constructive critique of this paper would be another paper offering a simpler, better method of using judgemental assessments than the method described here.

Regardless, the paper's prime purpose is to propose an evaluation technique that can be used when the staff of a business or government agency have the opportunity to decide how a program's objectives should be achieved when there are several projects that can be carried out and no "perfectly rational" quantitative method is available to select a best alternative. Such a situation arises with respect to recreation land acquisition and development, partly because of the difficulty of dealing with intangibles (see TN 34 on demand for recreation and price, and Coomber and Biswas and sources cited there on intangibles).

In the P.P.B. system or similar styles of government or business management practiced in North America, individual projects are seen as embedded components in a hierarchy of activities. The intended outputs of larger and encompassing programmes are decided on at the upper decision-making levels. At these levels apples and oranges are compared and decisions about how many (much) to consume (buy, provide) are made on political, ideological or traditional grounds. However, decisions to select individual projects to achieve a specific objective are made at the lower operational levels. Here the main concern is with the comparison of truly comparable alternatives and usually comparison is on the basis of cost-efficiency of different projects, or efficiency in some broader sense. One approach to efficient management has involved the use of project scoring to select the "best" project from among several that will achieve program objectives.

GOVERNMENTAL PROJECT EVALUATION AND MULTI-DIMENSIONAL SCORING

Often, when it is necessary in project evaluation to consider those so-called intangible factors that cannot be evaluated in economic terms, the various intangible factors considered relevant are assigned scores. The scores assigned to the different factors are added up and the projects evaluated on the basis of some total score. This process of scoring has often been referred to as the multi-dimensional scoring of projects.

Such multi-dimensional scoring practices are in wide use in academic, managerial and military spheres. Whether the alternatives to be ranked are students' papers, business projects, or prospective employees, the procedure followed is essentially the same; one conjures up the factors or

"dimensions" of an evaluation, ranking is done on each dimension, and then by some process a decision is made. But if there are two projects P(1) and P(2) to be ranked along two criterion dimensions A and B, there are four possible cases. They are:

a. P(1) is better than P(2) according to both A and B.

b. P(2) is better than P(1) accoraing to both A and B.

c. P(1) is better than P(2) according to A but P(2) is better than P(1) according to B.

d. P(2) is better than P(1) according to A but P(1) is better than P(2) according to B.

In the first two cases it is readily apparent which project would be preferred globally. In the last two cases a judgement is not readily possible because one must recognize that a project is the "best" because of only one criterion while acknowleaging that another project is better in terms of a different criterion dimension. Consequently, the decision maker may arbitrarily elect to treat the two criteria as equally important (even if the one has questionable validity) and make a judgement in terms of some total score for the two factors.

A CARDINALIZATION TECHNIQUE FOR IMPROVING MULTI-DIMENSIONAL SCORING

As just implied, one reason most ranking procedures use numbers that can be added, subtracted or otherwise compared is the intuitive appeal of avoiding those situations in which a decision cannot logically be made. Whether the given quantifications are valid or not is another issue. For example, consider the cardinalization of the previously mentioned rankings by means of assigning score-values to each project proposal along the two dimensions. If case d. is under consideration, one could (for example) be considering the situation shown in Table 1.

If the criteria are equally important, the respective "values" of the two projects can be reflected in their aggregated scores which are 15 and 10. But even if these really are the scores and the aggregate scores do not fall too close to each other, it still need not be clear which project truly ranks better overall. Yet this type of scoring aggregation is widely used with various degrees of care.

The author claims that in order for the aggregate score values to be meaningful, a number of conditions have to be met. These include:

TABLE 1

PROJECT SCORES FOR TWO PROJECTS
ON TWO CRITERION DIMENSIONS

	Project Number 1	2
Criterion A	7	8
Criterion B	8	2
Aggregate Scores	15	10

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TABLE 2

DETAILS FOR CALCULATING PROJECTS SCORES

Project	1	2	3	4
A. PROJECT RANKS				
Dimension A	1	4	2	3
Dimension B	4	2	3	1
Dimension C	3	2	4	1
B. PROJECT SCORES				
Dimension A	100	25	75	50
Dimension B	10	70	40	100
Dimension C	40	70	10	100
C. "NORMALIZED" PROJECT SCORES				
Dimension A	100	25	75	50
Dimension B	7.5	52.5	30	75
Dimension C	20	35	5	50
NORMALIZED PROJECT SCORE TOTALS	127.5	112.5	110.0	175.0

TOTAL "NORMALIZED" PROJECT SCORE = 127.5 + 112.5 + 110.0 + 175.0 = 525.5

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Condition 1. The criteria dimensions along which scores are taken must be "relatively" independent of each other (to avoid redundancy of dimensions);

Condition 2. The dimensions affecting the choice to be made should be relevant to the evaluation of alternatives being considered to achieve the objective of the program.

Condition 1 implies that the criteria dimensions used should not involve a number of variables that are merely different names for the same phenomenon. In applied terms, an individual count of each bacterial species in a water sample to determine the degree of pollution is redundant when an aggregate count of certain types of bacteria describes it sufficiently. Each species count in some sense describes the same thing. Similarly, from a parks management perspective, if a score is to reflect whether there is or is not historic development and to reflect the degree of that development from a check list of kinds of historic developments, then it is more appropriate to incluce a single variable (possibly a Guttman scale value) than to include a number of variables. Usually if, say, an historic building exists, artifacts, signs, habitation and other conditions "automatically" exist, so it is redundant to register their existence by having a great "checklist" of variables to use in "scoring" the site. The aggregate score obtained by summing the scores on the individual variables will be a poor site selection criterion and a poor general indicator of the nature of the site.

Pursuing the earlier example, the existence of certain bacteria in an area designated for swimming is only relevant if these bacteria represent a hazard or are present when some hazard is likely. The total aggregate count of harmful bacteria may indicate the level of pollution to a manager of the area. One count, rather than counts of a variety of species, tells the planner whether or not the water is sanitary enough for swimming.

Turning to the actual operation of scoring, it is usual that for each specific criterion dimension the most favourable alternative is given the score of 100. Similarly the least favourable alternative is given a score of 0 to 1; the remaining projects or alternatives are ranked between the two extremes. This effort is referred to as the "within variables scaling".

But the problem with "within variaoles scaling" is that, with respect to each variable, the best alternative is not generally 100 times more than the lowest ranking project. Realistically, this magnitude of difference in ranking does not occur very oftent In their 1968 proposal to the California State Department of Parks and Recreation, Alfred Baxter and Associates showed how simply this problem could be eliminated (see Reference 3). Their solution was to give the least favourable project a score that reflected its "status" in relation to the alternative that ranked 100

along the same dimension.

This scoring method encourages one to use his insight about a relation to express the fact that, for example, along dimension i, the best alternative is "4 times" more preferable than the worst alternative. Such an insight would be expressed by giving the poor project a score of 100/4 = 25. Now if on criterion j, the preferred alternative is 20 times better than that of the least preferred, the least preferred would receive a score of 5. (Because it is then assumed that the other projects take values at equal intervals between the best and the worst, the inclusion of a very bad project in the ranking will automatically reduce the value of intermediate projects relative to the best. An exceptionally good project will have the opposite effect. As a partial solution to this bias, not only the worst, but the median project (and even the 25th and 75th quartile projects) should be compared to the best, with intermediate projects taking values at equal intervals between.)

The flexibility introduced by not setting the lowest score at zero means in some way that "within variables scaling" is considered independently of the weighing of the variables. When "within variables scaling" has been accomplished, there remains the problem of assigning relative importance to each criterion dimension. Because each criterion dimension has a highest score of 100, assigning importance to the dimensions is independent of scaling within the dimension. What must be done is to compare the criteria that score 100, regardless of the project to which they apply and evaluate how variable X should relate to variable Y, variable Y to variable Z, etc. until one has, say X/Y = 4, Y/Z = 2, Z/W = 1, W/M = 1.1. The series just given suggests relative weights of 8, 2, 1, 1, .9 for X,Y,Z,W,M respectively.

The Alfred Baxter and Associates (see Reference 3) criterion dimensions for a cost-benefit scaling procedure to evaluate land for acquisition as a park can be used to illustrate in applied terms the import of the concepts reviewed to this point. Their criteria are:

1. Suitability for state acquisition;

2. "Ability" of the site to generate demand under a given development option;

3. Endangered future availability;

4. Quality and balance of the recreation experience provided;

5. Economic contribution to the surrounding community;

6. Open-space values;

7. Appropriateness in meeting deficit in recreation facilities.

These criteria were given the following set of weights: c1 = 100, c2 = .67, c3 = .51, c4 = .85, c5 = .33, c6 = .35, c7 = .62. Now, the merit of these consultants' handling of "within variables scaling" has already been acknowledged. But the adequacy or appropriateness of the above criterion dimensions with reference to conditions 1 and 2 cited earlier is dubious. The Baxter and Associates' criteria 3, 4, and 6 are meaningful. However, criterion 7 appears to be misplaced: there is no need for any project if there is no present or future deficit in recreation facilities recognized. As to criteria 2 and 5, the degree of relevance of these criteria should be dealt with by some type of economic analysis (as suggested later). Artibrarily assigning them weights ignores the fact that they are two interrelated factors, which should be considered as part of a rigorous, totally quantitative cost-benefit analysis. Finally, suitability (stated as criterion 1) should not be used as a criterion because it refers either to ability to generate demand under some development option (criterion 2), or to such factors as land quality for development (criterion 4) or economic suitability (criterion 5). Its inclusion involves either redundancy or irrelevance and may even be a guess at the scale to be derived as part of the scale. In the latter case this "cooking" factor which has the highest weight of all criterion dimensions is simply used to bias the final score.

INTEGRATING MULTI-DIMENSIONAL SCORING WITH COST EFFECTIVENESS ANALYSIS

Thus far, a clear distinction between how the variables that can be measured economically should be treated and how intangible variables should be treated has not been made. But, as implied in the last section, this is where the Baxter and Associates' scoring method has shortcomings.

A. There is a great temptation to over-weigh the mass of non-output-oriented (intangible) criteria with respect to "production efficiency".

B. An adequate link between "suitability" and the classical cost-effectiveness, "C-E", approach is not specified: there is a need to tie the suitability of a project more directly to its output to cost or quantity to cost ratio, "O/C".

It is important to account for the non-quantifiable aspects by a scoring system, but it should not be at the expense of the quantifiable ones (i.e. those directly

expressible as output or cost figures, or expectations of output or cost).

In short, the manager must realize that the ultimate aim of project evaluation is to produce output and not abstract score figures. Accordingly, the role of scoring should be limited to the production of some index of "aggregate suitability". This "aggregate suitability" may modify the output/cost ratio but it should not be possible for it to dominate an evaluation unless this is a clear and conscious choice of the manager responsible for project selection.

The preceding discussion gives the rationale for the third condition for scaling in project selection:

Condition 3. Overall suitability of a project should be determined by using a multi-dimensional scoring method on "intangibles" to define a score that can be used to modify a C-E evaluation (1) to a fixed degree, and (2) in a well defined and understandable way.

To achieve "true" integration of the two kinds of results, the manager may, for example, calibrate his aggregate "intangible" score in such a way that for an average suitability score, the output to cost ratio, Q/C, becomes the only consideration.

Consider that a recreation facility or service manager's intuition can be used to decide what percentage of influence, "d", intangible factors should have on the tangible output/cost ratio for particular projects being evaluated. Then it is an easy matter to recalibrate the total scores to get an index, IS, that will have a value of 1 + d for the project with the lowest intangible total score and will have a value of 1 - d for the highest score. If d = .25 then IS will be .75 for the lowest score project and 1.25 for the highest scoring project. The transformed values are merely calculated using the following equation which is written in a way that makes it easy to see the rationale on which the equation is based. The equation is to compute IS(j), the index for the project j is:

$$IS(j) = \frac{1.0+(\text{Score for project } j-(\text{Best Score}+\text{Poorest Score}))/2}{(\text{Best Score} - \text{Poorest Score})/2}$$

To emphasize why IS(j) was calculated it seems reasonable to call it the index of intangible project suitability.

Now, if one has the results of a rigorous cost efficiency analysis, then for each project, j, Q/C (j) is available. The crux of what is proposed here is that IS(j) can and should be used as a multiplier of Q/C (j) to produce a modified cost-efficiency ratio (to become the "cost-effectiveness ratio"):

M Q/C (j) = IS(j) (Q/C (j)).

Given that IS(j) has been calculated using the scaling approach suggested and that relevancy and redundancy of the variables used in calculating IS(j) have been appropriately considered, the manager ends up with a MQ/C (j) that is influenced by at most a known amount by intangibles. Assuming that Q/C (j) was calculated correctly, decision making should benefit from the very rational use of information on intangibles endorsed here.

APPLICATIONS OF THE METHOD OF CALCULATING THE INDEX OF INTANGIBLE SUITABILITY TO LAND ACQUISITION DECISION MAKING

Assume that four pieces of land are proposed for acquisition under, for instance, a Province's recreation program. Assume that three dimensions of intangible factors were felt to be relevant, and the rankings of 4 developments along them are given in Table 2 (Part A). Assume further that, along dimension A, the best proposal is deemed, by some evaluation committee, four times preferable to the worst and that this ratio is equal to ten for both dimensions B and C. This would lead to the three cardinalizations shown in Part B of Table 2 which are the "within variables scoring". To compare across criteria assume that the evaluation committee assigned the relative weights 1.00, .75 and .50 respectively to dimensions A, B and C. Applying these weights to transform the scores in part B of Table 2 one gets the results shown in part C of Table 2. The project scores are then easily derived by totaling across criteria in Part C of Table 2. The results are shown at the bottom of Table 2. As we can see, the spread of "suitability" values is from 110.0 to 175.0.

Assuming a spread of 10 percent is all that top management is willing to concede to considerations other than the project efficiency, the aggregate score must be recalibrated according to procedure introduced earlier to yield an index IS that ranges in value from .9 to 1.1 and which is centred around the mean value of the intangible scores for all projects considered.

Using the formula to calculate IS(j) with d = .1 results in:

$$IS(j) = \frac{1 + 2(.1)(\text{score for } j - (175 + 110)/2)}{175 - 110}$$

and IS(j) = 1 + .00308 (j - 142.5)

So the index values are .95, .91, .90 and 1.1 for projects 1 to 4 respectively. Then it is only a matter of multiplying and dividing to get the columns in Table 3 to have the modified project evaluation information shown in that table.

TABLE 3

DATA AND FINAL COMPUTATION OF RESULTS TO OBTAIN THE MODIFIED COST-EFFECTIVENESS RATIO FOR FOUR PROJECTS

Project	1	2	3	4
Total Output* (physical units)	15	30	10	20
Total Cost* ($,000's)	20	30	10	15
Output-to-cost ratio Q/C	0.75	1.00	1.00	1.33
Suitability (IS)	0.95	0.91	0.90	1.10
Modified Cost-Effectiveness Ratio	0.71	0.91	0.90	1.46

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* Outputs and costs are to be discounted to their present values.

Actually, in this example, project 4 would have been selected even if the IS(j)'s had all been equal (it is not being pushed upwards by the non-quantifiable aspects A, B, and C of the situation). However, if the realization of project 4 was barred because of some rigid constraint (e.g. political infeasibility) the method permits identifying the next alternative which would be project 2 (two) in this case.

SUMMARY AND CONCLUSIONS

As pointed out, ranking alternatives according to several criterion dimensions by the means of an aggregate score is widely practised. Given the faults which have been indicated in the procedures usually used, it is particularly unfortunate that the minor modifications suggested here are not regularly used. When it is recognized that the primary objective of an individual project is to produce tangible output rather than an intangible score the importance of

separating the intangible analysis from the tangible analysis is not hard to recognize. In fact, since the author suggested the use of a scaling technique suggested by others, the only original contributions of the article are the suggestion that tangibles be treated separately and the presentation of a way to do this. The correct role of the index of intangible suitability, too commonly used as the sole ranking criterion, is to serve as a modifier of the Q/C ratio.

In a practical vein, if the reader basically accepts the approach suggested he may find it useful to have Steps 1 to 6 as a guide in doing his own analyses. The actions suggested follow logically but without some thought or experience with the technique suggested, one might end up doing computations or taking other actions that the following indicate as unnecessary.

Step 1 Work out the Q/C ratios and, if there are no intangible factors to consider, the analysis is complete. The project with the best Q/C ratio is selected to be carried out.

Step 2 Ask management to decide on the d value for the particular situation being considered. If the best project's Q/C ratio is more than 1 + d/1 - d times the second best there is no need to go any further in order to find the most suitable alternative. The higher Q/C ratio cannot be "pulled" down to make it of a lower rank by any non-qualifiable influences being taken into account.

Step 3 If criteria other than mere efficiency are deemed relevant, then list the non-quantifiable factors that are deemed relevant. Make sure these are truly choice-dimensions (i.e. pure criteria). Remove those not obviously called for (irrelevant or redundant) and those better expressed as constraints.

Step 4 Establish the "within variables scoring" rationale.

Step 5 Establish the between dimension weights and use these and the special formula to get IS(j)'s.

Step 6 Rank projects according to their modified cost-benefit ratios.

This will establish the ranking of the alternatives according to all criteria dimensions, output-quantifiable or

not. But one consideration not raised previously is that, in practice, situations might arise in which the more cost-effective projects are not the largest ones. It may occur for example that in order to supply all user-days of recreation or in order to exhaust the budget, some of the lower ranking projects may have to be selected along with a best project. But, this is a problem of budget allocation and the issues that arise are too numerous to consider here.

In conclusion it seems important to reiterate that when decisions are to be made concerning the choice of projects for the allocation of funds, decision makers should examine all the factors involved -- whether they are quantifiable or non-quantifiable. At the same time the major objective of developing a facility must not be lost; output is what an agency wants. The effectiveness of the agency is evaluated by just that.

In addition, a certain amount of intuition about how the intangibles and non-quantifiable variables influence the output is desirable. In order to use this intuition effectively, a systematic procedure is needed. This paper has demonstrated one way in which a systematic integration of the multi-dimensional scoring method into the common cost/effectiveness analysis can be made.

It is the last point that best typifies the type of analyses being suggested throughout. It is not really that it is never-ending, but rather that different kinds and depths of analyses may be used depending upon the problems being confronted. And, of course, initial analyses will suggest further questions. While unexplained variance, or more euphemistically, unknowns, will persist and call for judgement based on the experience of planners, it is certain that helpful guidance will stem from such quantitative study.

MEASURES FOR ASSESSING THE SIGNIFICANCE OF OBSERVED PARTICIPATION IN RECREATION ACTIVITIES

J. Beaman and J.B. Leicester

ABSTRACT

At present, standards such as "x facilities per thousand people" are used as the basis for policy, and facility and program planning. However, these standards do not take into account such population characteristics as age and sex which directly influence the type of recreation programs required as well as facility design. Consequently, the reliability of the currently used standard or "general standard" is questionable. This paper presents an evaluation technique that considers the age-sex variable and postulates "Internal Standards" as a means of assessing the significance of participating in recreation activities.

The Internal Standards are derived from recreation participation records available for existing recreation facilities and programs. Population characteristics, age and sex, as well as the general class of recreation activity (i.e. athletic, social, etc.) information must be available before rates of participation can be determined. It is claimed that the minimum level of data required for making decisions in a large-scale operation is often the kind generated by the proceedure described.

OBJECTIVE

The objective of this paper is to present a means of assessing the significance of participation and frequency of participation in recreation activities in relation to the planning and management processes for recreation areas and facilities.

INTRCDUCTION

The current application of recreation facility standards such as "X" space or facilities per thousand people, which is accepted and used as a basis for policy, facility, program and area planning, leaves much to be desired. This is so because the utilization of these standards fails to take into account such factors as a population's age and sex characteristics; programs available; geographic accessibility of facilities, all of which have a marked effect on the type of recreation facilities and programs that will be used. Because of the

abundance of work showing the importance of age, sex and other factors in explaining participation patterns no attempt is made to review this literature (probably the best known works are Volumes 19 and 20 of the O.R.R.R.C. Report).

The general widespread use of the type of recreation facility standards referred to above can be partially explained by their availability as in the U.S. Department of the Interior's text, Outdoor Recreation Space Standards (see Reference 21). This and similar books are devoted to the listing of standards for recreation areas and facilities for a comprehensive assortment of outdoor activities. In such volumes, there is a mechanistic matching of facilities need to numbers of people. Of course for planning and management purposes one could go to the other extreme of elaborate data collections and analysis involving the use of factorial and cluster programs. However, interpretation of the results of such sophisticated and costly programs are generally beyond the means of the majority of recreation administrators and planners, and so go unused.

What is needed is a relatively simple methodology to facilitate evaluation and planning decisions and to present such is the business of this article. It is important to note that although this paper deals with "national" recreation management and planning, the approach can also be used in neighborhood, municipal, regional or provincial contexts. Actually, the data used in this presentation were taken from the Canadian Outdoor Recreation Demand Study and detailed documentation on them is provided in the CORD Study Data Documentation Volume. The data used were collected in 1972 from each of the 4000 individuals, ten years of age and over, on their participation in eighteen outdoor recreation activities. But, the method of analysis presented here was developed by the authors in 1967 while conducting a study of participation at community centres in the City of Winnipeg. Rather than conducting a survey of Winnipeg's residents, existing participation data from community centres were used in generating assessment measures.

COMPUTATIONS

The rationale behind the assessment procedure presented is simple. Once the rudimentary procedure is understood, the relevance of a myriad of variations of the basic procedure to planning or to management problems becomes apparent. Also, how the appropriateness of different assessment measures depends upon the objectives of a given analysis can be easily explained when the mechanics of computing assessment measures can be ignored and the focus of discussion can be the "meaning" of the numbers computed. It is for these reasons that this section is devoted to introducing the computational procedure.

Before presenting some information on obtaining the numbers in Table 1, it is convenient to give interpretations of some of these numbers both to aid one in reading Table 1

and the discussions regarding it. So to proceed, one should look in Table 1 and find the following weighted survey results which relate to peoples participation in outdoor recreation between 1 November 1971 and 31 October 1972:

(1) 19 = Number of Male Historic Site users age 10 to 19 for the Atlantic Provinces

(2) 91 = Total number of visits by 30 to 49 year old Western Canadian females interviewed, to Historic Sites (amount of Use)

(3) 59 = Number of 10 to 19 year old Atlantic Provinces males interviewed

(4) 46 = Number of 30 to 49 year old Western Province females interviewed

(5) 2.96 = Average number of Historic Site visits by 10 - 19 year old Atlantic Provinces males (Amount/Number of participants)

(6) 5.05 = Average number of activities participated in by 30 to 49 year old, Western Canadian females who participated in any of the 18 activities considered (amount/mumber of participants)

(7) 39 = Number of 30 to 49 year Ontario females who participated in at least one of 18 activities.

(8) 259 = Total number of the 18 activities participated in by Quebec males 50 or more years of age.

Reference to weighted survey results was made above because in the national survey from which data were obtained it was necessary to give different weights to different individuals to reflect the importance the individual should have. For details on the survey design and weighting one may see the CORD Study Data Documentation, specifically the chapter on national surveys.

To understand what information on total numbers of participants and amount of participation means in Table 1 is simple when one considers historic site use or fishing. In the case of these two activities the survey data include the answere to the question "How many times did you participate in the activity X?" (where X is a list of 18 activities). If a person indicated some participants one simply adds up the weights for all of the participants. The total amount of

participation for people in a certain category (e.g. age-sex group) is obtained by multiplying the number of times that each individual indicated he participated by the weight that that individual has and adding up these products for all individuals in a certain category. For those who are not familiar with weighting of data, it is easy to see that each individual has a weight of 1 so that what is being added up is the number of times that the individual says they participated.

TABLE 1

INFORMATION ON NUMBERS OF PEOPLE INTERVIEWED, NUMBERS PARTICIPATING IN THREE CLASSES OF ACTIVITIES AND AVERAGE AMOUNT OF PARTICIPATION PER PARTICIPANT (AMOUNT/PARTICIPATION)

		Number of Participants					Amount of Participants				
	SEX	Region					Region				
Age Group		Atl.	Que.	Ont.	West	B.C.	Atl.	Que.	Ont.	West	B.C.
		HISTORIC SITE USE									
	M	19	62	99	27	45	56	151	313	232	129
	F	19	46	109	19	35	169	124	393	67	107
		FISHING									
10-19	M	42	101	152	29	70	857	1003	2428	398	888
	F	10	60	68	20	31	65	428	794	103	139
		18 ACTIVITIES GROUP									
	M	56	179	216	49	108	402	1309	1746	396	815
	F	42	171	189	52	101	250	1088	1340	410	704
		HISTORIC SITE USE									
	M	10	33	65	11	33	54	401	328	54	134
	F	15	40	54	16	29	72	185	230	48	181
		FISHING									
20-29	M	16	57	60	22	33	116	494	763	152	271
	F	7	21	37	8	24	32	79	323	20	141
		18 ACTIVITIES GROUP									
	M	30	101	124	33	69	159	628	784	172	417
	F	34	107	125	25	67	157	506	762	151	396
		HISTORIC SITE USE									
	M	16	47	71	19	25	75	116	312	150	121
	F	10	54	76	19	39	37	208	277	91	150
		FISHING									
30-49	M	30	56	83	23	39	318	426	615	267	493
	F	11	29	40	7	20	143	195	261	43	179
		18 ACTIVITIES GROUP									
	M	39	121	166	46	74	183	567	825	235	383
	F	32	157	166	39	83	118	601	785	197	383
		HISTORIC SITE USE									
	M	7	20	49	17	19	20	56	306	162	59
	F	16	30	45	13	28	32	213	199	55	123
		FISHING									
50+	M	8	22	50	16	30	123	146	356	221	518
	F	0	9	8	7	7	0	70	92	109	40
		18 ACTIVITIES GROUP									
	M	25	82	131	38	68	82	259	435	147	291
	F	31	95	114	36	62	89	277	351	119	216

TABLE 1 (contd)

Age Group	"	Amount/Participation Region Atl.	Que.	Ont.	West	B.C.	Number Interviewed Region Atl.	Que.	Ont.	West	B.C.
		HISTORIC SITE USE									
	H	2.96	2.44	3.16	8.59	2.86					
	S	8.89	8.9	3.60	3.53	3.05					
		FISHING									
10-19	F	20.4	9.9	15.97	13.72	12.68	59	191	210	49	110
		6.5	7.11	11.67	5.15	4.48	43	177	196	53	101
		18 ACTIVITIES GROUP									
	1	7.18	7.87	3.08	8.08	7.45					
	i	5.95	6.24	4.25	7.89	6.97					
		HISTORIC SITE USE									
	H	5.1	12.15	5.04	4.91	4.06					
	S	4.8	4.62	4.25	3.0	6.24					
		FISHING									
20-29	F	10.37	8.59	12.71	6.90	8.21	32	110	129	33	71
		4.57	3.76	8.72	2.5	5.89	39	113	140	26	69
		18 ACTIVITIES GROUP									
	1	4.63	6.21	6.32	5.21	6.04					
	i	4.59	1.46	6.09	6.04	5.91					
		HISTORIC SITE USE									
	H	4.69	2.34	4.53	7.89	4.84					
	S	3.7	3.84	3.64	4.79	3.85					
		FISHING									
30-49	F	10.6	7.6	7.39	11.61	12.64	44	144	180	48	80
		13.9	4.96	6.52	6.14	8.95	44	177	230	46	100
		18 ACTIVITIES GROUP									
	1	4.69	4.68	4.96	5.11	5.17					
	i	3.69	3.79	4.73	5.05	4.61					
		HISTORIC SITE USE									
	H	2.85	2.8	6.24	9.53	3.11					
	S	2.0	7.1	4.42	4.23	4.39					
		FISHING									
50+	F	15.33	6.63	7.12	13.81	17.27	44	lll	177	49	87
		0	7.77	11.5	15.57	5.71	46	132	175	43	85
		18 ACTIVITIES GROUP									
	1	3.24	3.16	3.32	3.87	4.24					
	i	2.87	2.91	3.07	3.31	3.44					

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TABLE 2

PER CAPITA PARTICIPATION AND AMOUNT RATES, AND NORMALIZED PER CAPITA PARTICIPATION AND AMOUNT RATES (BASED ON DATA IN TABLE 1)

Age Group	SEX	Per capita Number of Participants — Region: Atl.	Que.	Ont.	West	B.C.	Per capita Participation — Region: Atl.	Que.	Ont.	West	B.C.
		HISTORIC SITE USE									
	M	.32	.32	.47	.55	.41	.95	.79	1.49	4.73	1.17
	F	.44	.26	.56	.36	.35	3.93	.70	2.01	1.26	1.06
		FISHING									
10-19	M	.11	.53	.72	.59	.64	14.53	5.25	11.56	8.12	8.01
	F	.23	.34	.35	.38	.31	1.51	2.42	4.05	1.94	1.38
		18 ACTIVITIES GROUP									
	M	.95	.94	1.03	1.00	.98	6.81	6.85	8.31	8.08	7.41
	F	.98	.97	.96	.98	1.00	5.81	6.15	6.84	7.74	6.97
		HISTORIC SITE USE									
	M	.31	.30	.50	.33	.46	1.69	3.65	2.54	1.64	1.89
	F	.38	.35	.39	.62	.42	1.85	1.64	1.64	1.85	2.62
		FISHING									
20-29	M	.50	.52	.47	.67	.46	3.63	4.49	5.91	4.61	3.82
	F	.18	.19	.26	.31	.35	.82	.70	2.31	.77	2.04
		18 ACTIVITIES GROUP									
	M	.94	.92	.96	1.00	.97	4.97	5.71	6.08	5.21	5.87
	F	.87	.95	.89	.96	1.00	4.03	4.48	5.44	5.81	5.74
		HISTORIC SITE USE									
	M	.36	.33	.39	.40	.31	1.70	.76	1.73	3.13	1.51
	F	.23	.31	.37	.41	.39	.84	1.18	1.36	1.98	1.50
		FISHING									
30-49	M	.68	.39	.46	.48	.49	7.23	2.96	3.42	5.56	6.16
	F	.25	.16	.20	.15	.20	3.25	1.10	1.29	.93	1.79
		18 ACTIVITIES GROUP									
	M	.89	.84	.92	.96	.93	4.16	3.94	4.58	4.90	4.79
	F	.73	.89	.82	.85	.83	2.68	3.40	3.87	4.28	3.83
		HISTORIC SITE USE									
	M	.16	.18	.28	.35	.22	.45	.50	1.73	3.31	.68
	F	.35	.23	.26	.30	.33	.70	1.61	1.14	1.28	1.45
		FISHING									
50+	M	.18	.20	.28	.33	.34	2.80	1.32	2.01	4.51	5.95
	F	0	.07	.05	.16	.08	0	.53	.53	2.53	.47
		18 ACTIVITIES GROUP									
	M	.57	.74	.74	.78	.78	1.86	2.33	2.46	3.00	3.34
	F	.67	.72	.65	.84	.73	1.93	2.10	2.01	2.77	2.54

		Normalized Per capita Number of Participants					Normalized Per capita Participation				
	S	Region					Region				
Age	E										
Group	X	Atl.	Que.	Ont.	West	B.C.	Atl.	Que.	Ont.	West	B.C.
				HISTORIC SITE USE							
	M	.58	.58	.85	1.00	.75	.20	.17	.31	1.00	.25
	F	.78	.46	1.00	.64	.62	1.00	.18	.51	.32	.27
				FISHING							
10-19	M	.98	.73	1.00	.82	.88	1.00	.36	.79	.56	.55
	F	.60	.89	.92	1.00	.81	.37	.60	1.00	.48	.34
				18 ACTIVITIES GROUP							
	M	.92	.91	1.00	.99	.95	.82	.82	1.00	.97	.89
	F	.98	.97	.96	.98	1.00	.75	.79	.88	1.00	.90
				HISTORIC SITE USE							
	M	.62	.60	1.00	.66	.92	.46	1.00	.69	.45	.52
	F	.61	.56	.63	1.00	.67	.70	.62	.62	.70	1.00
				FISHING							
20-29	M	.75	.77	.70	1.00	.68	.61	.76	1.00	.78	.65
	F	.51	.54	.74	.88	1.00	.35	.30	1.00	.33	.88
				18 ACTIVITIES GROUP							
	M	.94	.92	.96	1.00	.97	.82	.94	1.00	.86	.96
	F	.87	.95	.89	.96	1.00	.69	.77	.94	1.00	.98
				HISTORIC SITE USE							
	M	.90	.82	.97	1.00	.77	.54	.24	.55	1.00	.48
	F	.56	.76	.90	1.00	.95	.42	.59	.68	1.00	.76
				FISHING							
30-49	M	1.00	.57	.67	.70	.72	1.00	.41	.47	.77	.85
	F	1.00	.64	.80	.60	.80	1.00	.34	.40	.28	.55
				18 ACTIVITIES GROUP							
	M	.93	.87	.96	1.00	.97	.85	.80	.93	1.00	.98
	F	.82	1.00	.92	.95	.93	.63	.79	.90	1.00	.89
				HISTORIC SITE USE							
	M	.46	.51	.80	1.00	.63	.13	.15	.52	1.00	.20
	F	1.00	.66	.74	.86	.94	.43	1.00	.71	.79	.90
				FISHING							
50+	M	.53	.58	.82	.97	1.00	.47	.22	.34	.76	1.00
	F	0	.43	.31	1.00	.50	0	.21	.21	1.00	.18
				18 ACTIVITIES GROUP							
	M	.73	.95	.95	1.00	1.00	.55	.70	.74	.90	1.00
	F	.80	.86	.77	1.00	.87	.70	.76	.73	1.00	.92

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A problem in interpreting the information in Table 1 has to do with the "18 activities group". It is to know what is meant by this variable. This variable was created by determining how many out of 18 activities each individual participated in at least once. Therefore, a variable was created that has values between 0 and 18, with 0 indicating no participation in any of the 18 activities considered and 18 indicating participation in all of the activities considered. In the case of this variable, participated information indicates the proportion of the population that participated in at least one of the 18 activities (had a non-zero value for this particular variable). The amount of information for this variable was generated by multiplying the weight for an individual by the number of activities that the individual actually participated in at least once. So the grand total amount is the weighted total number of activities in which all individuals participated. This explains the interpretation given to items six, seven and eight of the definitions for Table 1 which were given earlier.

Two technical points deserve mention for those who may choose to work with the data used to perform this analysis. One will find that some people did not respond properly to the questions asked and consequently there are codes that do not correspond exactly to the certain number of times that a person participated in activity X the year before the survey. These codes indicate responses such as I participated several times or I participated monthly. Such codes were translated in a systematic way that is documented in the document section of the SPSS file from the data. The file is available from the LEISURE STUDIES DATA BANK, Waterloo Research Institute. The other point is, that for the purposes of the record the 18 activities on which the 18 activities group variable was based are:

1. Tent Camping
2. Trailer Camping
3. Pickup Camping
4. Hunting
5. Power Boating
6. Canoeing
7. Sailing
8. Bicycling
9. Fishing
10. Sightseeing - private vehicle
11. Snow Skiing
12. Snowmobiling
13. Picnicking/Cooking Out
14. Walking/Hiking
15. Ice Skating
16. Horseback Riding
17. Visiting Historic Sites
18. Driving For Pleasure

In themselves the numbers in Tables 1 mean little since they depend on the size of sample. For example numbers like (3) and (4) defined earlier are numbers to which a total number participating must be related. To correct the "totals" so that they reflect the distribution of population, a second group of numbers must be calculated. Here these rates are called per capita attendance coefficients (PAC) and are computed by dividing numbers in the upper part of Table 1 by corresponding numbers interviewed from the lower right section of Table 1. One can

see that the numbers in the upper part of Table 2 (such as the Per capita Frequency for Historic Site Use by western females 20-29) is obtained by dividing 48 from the upper right of Table 1 into 26 from the lower right.

The coefficient produced in this way is referred to as a per capita participation rate if it is based on participation figures, while if it is based on amount of participation it is referred to as per capita amount rate. In terms of numbers presented earlier one may note that there should be no misimpression that a per capita rate of participation reflects the behaviour of an "average" individual. The participation information shows that varying proportions of the population in different age and sex groups in different regions participate. Average amount numbers like (5) and (6) show that there is often a high level of participation by the participants in an activity five or more times per year, while one knows from the other information that less than half the population participates in that activity. Obviously, an average number of participation per person in the population gives a very deceptive picture of how participation is distributed over the population. These are obviously enthusiasts for particular activities whose 100 participations per year can become confused in an average with one participation by each of a hundred individuals or with two participations by 50 individuals, etc. One may note that one Canadian Outdoor Recreation Demand Study project carried out by Romsa (see TN 10, Table 9) indicates that many Canadians are "non participants" in outdoor activities while many others do little else than drive for pleasure. The 18 activities variable conveys similar information by showing that a very large part of the Canadian population only participated in one of the 18 activities considered during the year preceeding the survey.

One can see from the top part of Table 2 that in terms of participation in an activity the degree of service to each age-sex group in each region varies greatly. The distance participants must travel to historic sites, for example, varies in different areas of Canada as does access to fishing areas or the availability of many of the 18 activities considered. Socio-economic characteristics are also different in the various regions of Canada and these differences may affect interest or financial ability to participate in certain activities. These and other factors lead one to expect and accept the variation in per capita rates from age-group to age-group and from region to region. It is these kind of "internal" factors that are the factors of interest to recreation planners who need a standard against which to plan. Also the information conveyed by the variance in per capita coefficients is information that may be used by managers in assessing the effectiveness of a program or the viability of a proposed plan.

However, the per capita figures are not the most convenient figures to use in making comparisons which often should be made in planning. By looking at the top part of

Table 2 and the bottom part of Table 2 one will see that the simple operation of normalizing the per capita coefficient to the best coefficient for a particular age-sex group makes it much easier to tell at a glance what is going on in a given region. For example, one can see that Ontario or Western Canada consistently set the standard for participation have a coefficient of 1.00 for males and females for the different age groups but Quebec and the Maritimes sometimes set the standard in terms of frequency. Of course, Quebec City and Montreal residents visit a historic site as a regular part of a visit to downtown.

Regardless, the lower part of Table 2 is the focus of attention here for reasons that are made clear subsequently so the ratio of main concern in this paper is the relative attendance coefficient, RAC. As just noted, to get the RAC the PAC coefficients are normalized by dividing the best participation rate for a given age-sex activity group into the similar coefficients for other regions. Consequently, a group from a particular geographic area is compared to a standard that is set by people elsewhere (or themselves) with similar age-sex characteristics; thus an "Internal Standard" is defined. The "internal Standard Approach" is in fact the name given to the methodology described here when first developed by the authors.

FURTHER DEFINITION OF ASSESSMENT MEASURES AND RELATED CONSIDERATIONS IN USING THE MEASURES

The preceding section of this paper has presented a methodology for computing measures based both on participation in activities and amount of participation. One may wonder why both of these should be considered. Certainly, it cannot, in general, be concluded that considering both is redundant as already illustrated when regions that set a participation standard do not set the frequency standard. If the objective of an analysis is to understand the loading of facilities and there is not any particular concern with the equity (access by all the people in an age group) with which this loading takes place, then information on the amount of participation is certainly adequate for analysis.

However, consider for example that the participation information really amounts to presenting information on what percentage of the people in a given age-sex group, in a given area participate at all in an activity (or in a collection of activities). Now, if 10% of the people participate in an activity, even if this results in one participation per capita (based on the amount figures), there is not equity in the sense that there is a broad base of participation in the activity or class of activities (see TN 32 for another approach to considering equity). To cite one further example, just because the number of visits to National Parks in a year is in the millions does not mean that a high percentage of Canadians are using national

parks. Because the number of park visits in the province of Ontario residents is very large does not mean that a high percentage of Ontario residents are using Ontario parks, etc. Particularly when such factors as the repeat use of facilities by scouts, church groups, etc. results in some people having very high participation level, some people having nominal participation levels, some participating only a little and some not at all. Information on amount of participation can be extremely misleading (as in fact can information on participation at all).

The point that should be clear to the reader now is that in any analysis that is carried out the questions that must be asked, are: What is to be evaluated? What is an appropriate way to evaluate it? Should it be evaluated by determining what percentage of the population participates in an activity? It is more important for the objective of a given analysis to know about the amount of participation? Are both important, and if they are, how will results on these two factors be combined?

It is only through asking these kinds of questions that one will avoid the ad hoc use of an evaluation methodology possibly resulting in answering the right question with the wrong information, or answering a variety of questions with information that is quite irrelevant to what should really be done. As is indicated subsequently, there are cases when the RAC coefficient should not be used, but rather one should consider how participation is changing with age. Obviously when RAC's are computed age effects are eliminated from consideration. So, if this is the objective, one should not use the kind of analysis endorsed here and conclude because the RAC's do not vary with age that everything is fine as one moves from one age group to another. The method described has been chosen so that differences in participation by the different age groups can be ignored. This was done because such a policy orientation is relevant in a broad class of problems. The policy or planning matter of concern in such cases is whether people in the same age group in different areas are being served in an equitable way!

TRANSLATING TO PLANNING SCORES

As implied in the last section, recommendations to promote action in the programming or development of facilities can be made for age-sex groups in a specific locale by using the RAC. However, the difference between an RAC of .7 and one of .6 may be of no practical significance given the reliability of RAC coefficients, the accuracy of planning, the accuracy of policy formulation or for other reasons. The point here is that information should not be presented in more detail than is necessary or useful. Table 3 was prepared to reproduce the bottom part of Table 2 in as much detail as the authors thought was necessary in most planning. They believe there should rarely be the need for a

final display of RAC for planners or management to involve more than a 3 or 4 point scale (A, B, C or A, B, C, D). To present RAC in two significant figures, even if they are accurate, is presenting more information than is useful in a given program or facility planning exercise or in most program assessment and proposal evaluation exercises.

It should be clear that the RAC values defining the A, B, C, and D standards must depend on the particular situation being considered as well as the statistical concern that allows for the range in the RAC values. Clearly, there should be a wide leeway in how these values are defined. The planner may wish to express the fact that a general low level of cultural activity is deserving of priority consideration over actions in relation to another activity.

In terms of the results presented in Table 3, the following points should give the reader a practical insight into what was being alluded to above.

The scores in the lower part of Table 2 have been translated into A, B, C and D ratings in a way consistent to some extent with their variation so that at a glance one can see what is occuring. The scale for transformation is given in Table 3. The reason that a special scale is used for the eighteen activity group participation results is to make it clear that in this case an A score is considered to be any score above .8: variation between about .8 and 100 is not seen as being very significant. No behavioural basis really determined the choice out of 100 to 70 as a A score for participation nor was 100 to 75 chosen as an A score for frequency for any behavioural reason. However, the difference between the participation scale and the frequency scale was chosen intentionally so that with the frequency information one would be aware of the very broad range of variation of the frequency coefficient.

No more effort was spent on defining these translated scores so they would have meaning because the high level of geographic aggregation means that the coefficients do not mean too much in terms of behaviour. Obviously people's access to historic sites varies drastically within western Canada, the Atlantic provinces; infact all the regions considered. The same is true of people's access to opportunities to fish. A level of aggregation which focused attention on areas within which travel is reasonably feasible would result in coefficients which could be considered much more meaningful because then people would be related to the supply accessible to them. The material presented here was for illustration purposes, not as input to policy makers or as an example of the "level" at which analysis should be carried out.

STATISTICAL AND DATA GATHERING CONSIDERATIONS

In discussing the introduction of A, B, C, D scores it was mentioned that one reason for using such scores was not

TABLE 3

NORMALIZED PER CAPITA PARTICIPATION AND AMOUNT RATES (OF TABLE 2) TRANSLATED TO "NEED FOR ACTION SCORES"

Age Group	SEX	"Translated" Normalized Per capita Participation Rates — Region: Atl.	Que.	Ont.	West	B.C.	"Translated" Normalized Per capita Amount Rates — Region: Atl.	Que.	Ont.	West	B.C.
				HISTORIC SITE USE							
	M	B	B	A	A	A	D	D	C	A	C
	F	A	B	A	B	B	A	D	B	C	C
					FISHING						
10–19	M	A	A	A	A	A	A	C	A	B	B
	F	B	A	A	A	A	C	B	A	C	C
				18 ACTIVITIES GROUP							
	M	A	A	A	A	A	A	A	A	A	A
	F						A	A	A	A	A
				HISTORIC SITE USE							
	M	E	B	A	B	A	C	A	B	C	B
	F	B	B	B	A	B	B	B	B	B	A
					FISHING						
20–29	M	A	A	A	A	B	B	A	A	A	B
	F	B	B	A	A	A	C	C	A	C	A
				18 ACTIVITIES GROUP							
	M	A	A	A	A	A	A	A	A	A	A
	F					A	B	A	A	A	A
				HISTORIC SITE USE							
	M	A	A	A	A	A	B	D	B	A	C
	F	B	A	A	A	A	C	B	B	A	A
					FISHING						
30–49	M	A	B	B	A	A	A	C	C	A	A
	F	A	B	A	B	A	A	C	C	C	B
				18 ACTIVITIES GROUP							
	M	A	A	A	A	A	A	A	A	A	A
	F					A	B	A	A	A	A
				HISTORIC SITE USE							
	M	B	B	A	A	B	D	D	B	A	D
	F	A	B	A	A	A	C	A	B	A	A
					FISHING						
50+	M	B	B	A	A	A	C	D	C	A	A
	F	C	B	C	A	B	D	D	D	A	D
				18 ACTIVITIES GROUP							
	M	B	A	A	A	A	B	B	B	A	A
	F	A	A	B	A	A	B	A	B	A	A

TABLE 3 (contd)

The following scores define A,B,C,D for participation:

(1) Historic Site Use; and
(2) Fishing:
    100 - 70 = A
     69 - 40 = B
     39 - 0 = C

(3) 18 "Activities Group":
    100 - 80 = A
     79 - 0 = B

For frequency:

(1) Historic Site Use;
(2) Fishing; and
(3) 18 "Activities Group":
    100 - 75 = A
     74 - 50 = B
     49 - 25 = C
     25 - 0 = D

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to exaggerate the apparent accuracy of the coefficients that were calculated. Actually, in raising the issue of statistical accuracy two matters are important. For the moment these may be identified as:

(1) What cost is acceptable in carrying out a study?

(2) What accuracy is needed?

These two considerations are interrelated. If a survey is being carried out, or even if information is being collected through the use of administrative records so that a evaluation measures can be computed, cost increases as the amount of information collected and/or processed increases. If the acceptable cost for data collected is too low to produce worthwhile results, then a project should not be initiated. On the other hand, one of the most reprehensible practices now followed is that of establishing a budget for a project without consideration of what accuracy is needed. Someone decides that $40,000 is necessary to collect data and the number of interviews to be carried out is determined on the basis of having $40,000.

Part of the purpose of having a good statistical design for a survey is in seeing that the objectives of the survey are achieved at a minimum cost. If the kind of analysis

described in this paper is to be carried out and if that the planners are willing to accept certain error, then the objective of the survey design is to see that information is collected with an accuracy that is compatible with the planning needs. It may be necessary to carry out the survey as a "pre-test" to see what kind of accuracy can be obtained. The important step is to be able to state clearly how far one is willing to go from the qualitative RAC scores to an A, B, C, D type of scoring that is adequate for planners and thus to be able to state what accuracy is really needed.

While these considerations are important to the planner and administrator there are others that must be of importance to the survey designer or research person responsible for seeing that data are collected. Here is the problem of bias arising due to lapses of memory. There are other matters that need to be considered in the design of questionnaires and in administrating questionnaires that have to do with creating a disposition that will cause a person to respond correctly to a question.

One important point to note regarding statistical concerns and the difficulties that arise when information is obtained by surveys is that as indicated earlier administrative records may be the source of information for the kind of analysis described. Whether it is parks organizations that process information from hunting licences or Parks Canada that processes information obtained from some kind of permit, there are distinct advantages to using administrative information. In many cases it is quite clear what a permit entitles a person to do. Or if the issue of concern is not whether the person carried out the activities but simply that he was entitled to carry it out, then administrative records can be particularly good. There are a whole other class of administrative records which in fact are records of people's participation in certain activities and these records are ideal information on which to base analysis of amount of participation. The problem of recall bias is eliminated when such records are used and the only problem that remains is that of capturing all participation of a given type at facilities of concern (if in fact the concern is with all participation in a given activity or class of activity).

OTHER CONSIDERATIONS IN FORMULATING AN ANALYSIS CONSIDERING OBJECTIVES

The preceding discussion has treated participation in an activity as the "object of interest". However, to take a particular example, not only does the Federal Government operate historic sites, there are provincial historic sites and there are municipal and local as well as some private historical sites or displays. If different organizations or agencies are responsible for programs, it may be desirable to consider what proportion of the RAC is accounted for by

activities sponsored by each agency. Such an approach might in fact be useful to the agency in evaluating the degree to which their dollars are spent as effectively as the dollars of some other group involved in the same program area. Why should one not ask what percentage of the market for use of historic sites goes to National Historic Sites rather than to provincial or other historic sites? At the same time why should not the relative budgets be considered to look at the relative efficiency in investment? The preceding is taken as an example not because it is a particularly good example, but because many people may immediately react to it from a policy perspective. They may ask themselves if a National Historic Site really provides the same commodity as a provincial site or they may ask themselves some other relevant questions. Similarly in a municipal situation it is important that evaluations not proceed at a face value and result in criticism of an organization that works in a problem area because it incurrs a higher cost for the amount of participation that it encourages whereas a municipal agency appears to offer the same program at a relatively low cost. Evaluation is a tricky business. Evaluation based on a methodology being used without the insight derived from careful comparison of project objectives and project targets can be a destructive influence that calls something a failure when in fact it is a success.

Turning to a completely different matter, one should note that the coefficients suggested here are not the only ones that can be developed from the kind of data used. Many of the readers have already no doubt scanned the upper part of Table 2 and noticed how the per capita coefficients drop off with age. In many situations this drop off is justified because, as suggested earlier, any "discrimination" against age groups is a matter of policy. However, it is not inconceivable that an organization, in examining its policy, may wish to look at the relative situation of different groups over various ages in different geographic areas. In this case coefficients similar to the RAC coefficient could be developed by simply normalizing, by dividing by the largest PAC coefficient regardless of the age or sex group for which it occurred. This might be appropriate in the case of a national health and welfare program for which the objective was encouraging some kind of physical activity within a certain range of activities. In this case a variable like the 18 activities variable might be generated for several fitness activities and the results of the analysis would be meant to focus on the success of involving the Canadian population with respects to their being active in at least one of these groups of activities.

When one starts to broaden out the range of consideration along the lines indicated in the last paragraph, one often begins to think of the desirability of knowing whether or not a person actively participated in an activity. By careful definition of what is meant by being a regular participant it would be possible to get answers to the questions "Did you participate regularly in activity X?"

With the response to such a question one could prepare a table that would give a profile of people in terms of what they do regularly rather than what they may have happened to do at least once during a year. One could elaborate on the 18 activity kind of analysis to see where, between the extremes indicated by amount of participation and the minimum indicated by participation, people's regular participation lies. But unfortunately, pursuing any of these ideas becomes the topic for another paper. Also, pursuing them without particular objectives results in much obtuse and hypothetical comment. So, the authors consider it more important to terminate this section, hoping that some of the ideas presented allow the reader to see the broad range open for applying, modifying and extending the analyses technique introduced here.

THE ROLE OF THE PLANNER AND/OR MANAGER

The preceding material has been clear about the importance of objectives in deciding how the methodology proposed in this paper should be applied and regarding what data should be used. However, what it has not stressed is the importance of the planner and/or manager, not so much as a specifier of objectives but as an active and important element contributing to the actual analysis. In the original study in which the method presented here was developed, there were neighborhoods in which community recreation centre use was very low. Some of these neighborhoods had low use of facilities, lack of program, etc. Other neighborhoods showed low per capita use of community facilities because there were ethnic communities with such a high degree of solidarity that they did not use community facilities. Within the City of Winnipeg, Mennonite and Ukranian groups (to cite but two examples) have extensive facilities of their own either associated with ethnic community centres or with churches. It is important to recognize this relationship and to accept that it would be foolish to attempt to increase use of public facilities in these ethnic communities. It is necessary that the people involved in carrying out analysis be conversant with the areas that they are studying and the social and geographical factors that influence what goes on in those areas.

If the kind of anlaysis proposed here were carried out for a particular province, it would be relatively easy in most provinces to find geographic areas in which special considerations would be relevant in understanding the activities in which people participated. Much more obvious with respect to certain activities like hunting and fishing is that a game warden or resource manager can (from his knowledge of the availability of good hunting or good fishing) give a ready idea of what some of the variations and RAC coefficients mean without the need for becoming involved in mapping the amount of supply available or in developing maps of the potential to participate (see, for

example, TN 5, TN 16 and TN 17).

These comments are not meant to indicate that the results of analysis procedures such as those presented in TN 5 and 17 are not useful or that work on supply measurement procedures such as that reported in TN 16 is without value. Rather, the point which is seen as important enough to stress this article is that today there is a tendency to use overly sophisticated quantitative analyses and to put too much reliance on external experts (who unfortunately are often not experts) while ignoring a great deal of knowledge that is contained within the experience of people who know the area being studied. Yes, it is tricky using local knowledge without getting local bias but this does not mean one should not try.

CONCLUSION

It may appear that the authors are making an issue of something no more sophisticated than ordinary age specific participation rates. Yet, any economist, sociologist or demographer knows that though such rates are simple, their use is one of the most effective ways to understand a social phenomena where a large number of events are involved.

However, in conclusion the suthors feel it is important to stress again that the technical considerations reviewed should not dictate the ultimate decision as to the "real" significance of any coefficient. Every evaluation involves a policy decision and a data analysis methodology should not define policy, but only be useful in policy definition and evaluation. If it is policy not to provide recreation facilities or programs for adults or aged, it is not surprising that adults do not appear very frequently in attendance figures. Should it be a policy to provide school programs at historic sites in a certain geopgraphic area, the fact that this area sets the standard does not imply that the other areas are being deprived of a program to which they are entitled (or that they need). "The planning tool" which should not be forgotten is the integration of knowledge of the areas studied and of a political situation with the quantitative guidelines that can be set by defining measures using the methodology presented.

ESTIMATING THE ECONOMIC IMPACT OF PROPOSED PARKS

A Summary of the Report
ECONOMIC IMPACT OF NATIONAL PARKS IN CANADA
By Hildebrandt-Young and Associates Ltd.
Prepared Under Contract for Parks Canada 1970

Edited By
G.J. Gauthier and R.H. Stanley

ABSTRACT

To study the economic impact of establishing national parks, Parks Canada, in 1970, commissioned the firm of Hildebrandt-Young and Associates Ltd. to undertake a study that would review existing methodologies; propose a standard methodology for Parks Canada; and test this methodology on a proposed park.

This paper is a condensed version of the consultants' two-volume report. It is divided into three parts:

I. the conceptual framework;

II. the Gros Morne Park proposal; a case approach;

III. an annotated bibliography.

The original research does not propose the adoption of a specific methodology for all such studies, but does provide the reader with procedures for evaluating the impact of a National Park.

INTRODUCTION

The economic impact of establishing national parks has been of major interest to the Government of Canada for some years. In 1970, National and Historic Parks Branch, now Parks Canada, commissioned the firm of Hildebrandt-Young and Associates Ltd. to undertake a study (see Reference 27) that would:

(a) review existing methodologies;

(b) propose a methodology suitable for Parks Canada; and

(c) test this methodology on a proposed park.

This paper is a condensed version of the consultant's report. Although the organization of the paper does not follow the organization of the report, no new ideas on impact evaluation have been added in revising the paper. A commentary has been included at the end of the paper and it is followed by a short bibliography drawn, in part, from the annotated bibliography included in the report. All the entries in the original bibliography are not included as most of the issues are better (or more briefly) dealt with in more recent literature (see, for example, Reference 18).

This paper is not intended to provide a model to follow in doing benefit-cost analysis, or socio-economic impact studies. Rather, it is intended to give the flavour of some of the difficulties involved in undertaking such a task. Therefore, the procedures endorsed here should not be taken to be those which are officially accepted by Parks Canada. Parks Canada has drafted guidelines for the execution of socio-economic impact studies and these deviate considerably from the ones followed by Hildebrandt-Young. In fact, a paper titled "A Longitudinal Analysis of the Impact of the Creation of a Major Park" (TN 40) and the Canadian Outdoor Recreation Research Committee paper on the economic impact of parks (Reference 27) set out a number of Parks Canada's concerns with regard to the economic impact research that has been undertaken on its behalf.

Finally, because the title of the article does not make it clear, the reader may find it useful to note that the paper is in two parts:

(1) a theoretical framework; and

(2) the Gros Morne Park proposal: a case approach.

The first part of the paper introduces the concept of benefit-cost analysis, examines the types of costs associated with the establishment of parks, and then examines the types of benefits. Each cost and benefit is discussed, in so far as it is useful to do so, with respect to:

(1) its nature and elements;

(2) the problems of measurement;

(3) how these problems might be overcome; and

(4) presenting the cost or benefit in accounts.

The second part of the paper follows the same organization and includes tables presenting the estimated costs and benefits.

PART I

A THEORETICAL FRAMEWORK FOR THE EVALUATION OF THE BENEFITS AND COSTS OF NATIONAL PARKS

INTRODUCTION

Canadians both publically and politically are of the view that national parks are valuable. The federal government is, however, faced with the problem of determining what priority this view has with respect to competing programs, or in other words just how valuable any newly proposed park is to those who benefit and to those who must bear the costs. This value problem is complicated by the fact that many of the benefits and costs of park development are intangible or indirect. The cost of foregoing resource exploitation may not be a direct cost to the park, but is still very real to those who no longer hunt, fish, trap, etc. and to those who depend on them. The benefits of preserving Canada's natural heritage are intangible, but constitute one of the prime purposes for the establishment of a park. Furthermore, benefits and costs accrue differently to the nation and the federal government, the provincial government, and the residents of the proposed park and immediate vicinity.

COSTS

There are three types of cost associated with park creation: opportunity, capital and operating. Opportunity costs are the measure of the highest value which resources could have realized, had they not been dedicated to National Park use which preclude all mining, timber, harvest, etc. In other words, it is the measure of benefit foregone because resource exploitation, actual or potential, must be foregone in the area of the park. Capital and operating costs are meant in their traditional senses.

1. Opportunity Costs

In the case of a national park, these costs arise from the prohibiting of timber harvests, mineral development, commercial fishing, agriculture and other similar resource use. The components of the benefit foregone include wages and cost of plant and equipment (factor payments) which would be paid by firms engaged in extraction or harvesting, transportantion, processing or manufacturing the primary material into marketable, exportable or consumable form. Also included is a value commonly referred to as pure economic rent which represents the inherent value of the resource. It is the residual which remains when factor payments, including "normal profit", are subtracted from

market value.

There are also secondary benefits. The existence of a resource processing industry will create a demand for goods and services that can bring into existence in the region further industries to supply the demand (backward linkages). It can also create a supply of goods and services that will permit the creation in the region of industries who will use these goods and services as their inputs (forward linkages). Payments to factors (e.g. labour) get re-spent in the region (net of savings and imports from outside the region) and these spendings (again net of savings) are spent again and again, thus multiplying the impact of any payment made in the region. All these benefits are foregone if resource exploitation is prohibited.

Opportunity costs for a resource in a park exist when the resource has a value that will be lost if it is locked up in the park. From the national point of view opportunity costs usually reduce to the equivalent of pure economic rent plus the earnings of factors that would remain unemployed in the absence of resource development. However, in Canada, manpower is ordinarily almost fully employed (note that the Hildebrant-Young report was written in 1968) and capital is characteristically overemployed and scarce. Thus it can usually be assumed that where development of one national resource is foregone, capital and manpower will find employment in the development of other economic opportunities within the nation.

From the provincial point of view, the circumstance are very different. The resource potential of a province is, of course, much more limited than for the country as a whole. Foregoing the exploitation of a resource has a much more significant impact on the economy of a province than on Canada. If the capital and manpower for exploiting the resource is attracted to another province, the opportunity cost approaches the gross market value of the resource, and not just the economic rent as is the case from the viewpoint of the nation. The province also must consider the net effects of the forward and backward linkages (those occuring within the province) as opportunity cost.

Conceptual difficulties in the measurement of opportunity costs are negligible although Krutilla (see Reference 35) shows that matters are not all that clear. The key is correct description and understanding of the opportunities foregone. The calculation can be very complex, however, as often a great number of factor payments are involved. Actual accounting for these transactions is frequently impossible and some more general statistical measure must be used. Econometric input-output models, which measure the interaction of firms in the economy are in various stages of completion for a number of Canadian provinces and regions. (For example, Statistics Canada is just now (1976) getting provincial models into operation.) These can often provide a reasonable estimate of the net effect of foregoing economic opportunities. (The Department of Regional Economic Expansion does not at present accept

the estimates produced by these models.)

For accounting purposes, it is useful to consider opportunity costs as capital or operating costs. For example, the cost of purchasing a farm within the boundaries of the proposed park can be considered a capital cost but in fact it represents to the owner the present value of his net future income stream from the farm (i.e. his earning opportunity foregone).

2. Capital and Operating Costs

Established methods for treating capital and operating costs are widely accepted. These costs present no problems of measurement. Difficulty is caused by accounting for the effects of dislocating communities and persons living within the park. It is necessary to determine the amount of compensation to be paid both for real assets owned by members of the community and for hardship undergone in relocating. Here again the key is accurate description of the extent of dislocation. (Life tenancy is currently under consideration as an alternative to compensation.)

BENEFITS

There are four types of benefits generated by the establishment of parks: preservation, recreation, economic stimulation from tourist spending, and from government expenditure for the establishment and operation of the park. The first two benefits in particular pose significant problems of measurement, and no generally accepted method has yet been found to measure them satisfactorily.

1. Benefits of Preservation

One of the two principal purposes of a national park is preservation, for its ecological or scenic uniqueness, for the maintenance of the widest possible variety of existing species of flora and fauna, or for its "option value". Option value is the value attached by a person to the possibility of obtaining a good or service in the future, when he has no intention at present of using it, but when re-establishing the supply of that good or service would be excessively expensive or even technically impossible once it had been discontinued. While it is obvious that all three types of preservation have value, it is equally obvious that it is not possible to attach firm monetary estimates to these, although an attempt could be made in the last case where something is preserved for future use (in this case, recreation). The best that can be done is to present preservation as an unmeasured value which must be considered subjectively in the benefit-cost analysis.

2. Benefits of Recreation

The other principal purpose of a national park is to produce recreation benefits. National parks supply a wide variety of recreation services such as sightseeing, camping, water sports, hiking, skiing and wildlife observation. The main difficulty in measuring this benefit derives from the fact that the consumer does not pay (at least directly) for the benefits received, as it is the policy of the National Parks of Canada to make parks available free or at nominal cost to visitors.

In the private sector, price can be used as an indicator of benefit. While benefits received may be more than the price a consumer pays, the benefits will at least be no less. In the case of a park, however, price is zero or nominal, so it is not possible to use price as a proxy. It is therefore necessary to try to measure the benefits in some other way. From an extensive review of methods previously employed, three approaches offer some hope.

THE GROSS EXPENDITURE METHOD, usually based on interviewing a sample of visitors, gives the total amount of tourist spending as reported by tourists themselves. While this method may provide guidelines for investment in tourist accommodation and so on, the visitor's expenditures are for fuel, food and accommodation, and not for access to the park. Therefore they do not necessarily reflect how the visitor rates the park's value.

THE UNITED STATES FEDERAL AGENCY PROCEDURES, which are widely used in estimating recreation values, consist essentially of assigning standard dollar values to each activity park visitors participate in, multiplying the values by the number of visitors participating in each activity, and summing the values to obtain an estimate in dollar terms of benefits provided by the park. This approach has serious shortcomings: the values assigned are completely arbitrary, and they are assumed to remain constant over the project's life expectancy. However, this approach can provide, in the view of Hildebrant-Young and Associates, a rough approximation of benefits obtained. In addition, the values have the advantage of appearing reasonable both to those who use the parks and those who must consider allocating funds to park development.

THE HOTELLING METHOD is an attempt to determine the benefits by theoretical means. Users are grouped into geographical zones within which travel costs incurred in reaching the recreation site are relatively constant. For each zone, a participation rate per unit of population is found. It is assumed that the participation rate for a given zone would decline to the level of a more distant zone if residents of the first zone were charged a user's fee equal to the difference in travel costs facing the users in each zone. Participation rates can then be estimated for various fee levels. When it is known what "price" visitors in a zone would be willing to pay to visit the park, consumer surplus becomes the difference between this and what they do pay.

There are several theoretical problems with the Hotelling method. There is no guarantee that behaviour in one zone can be used to predict behaviour in another. Secondly, changing the fee would not necessarily leave the quality of the recreation experience unchanged (e.g. congestion might increase). There are practical problems as well: (1) demand estimates are extremely sensitive to the choice of zone boundaries; (2) it is difficult to define minimum necessary travel costs; (3) it is difficult on a multi-purpose trip to separate benefits attributable directly to the park visit. Successful application of this method have so far been limited to the analysis of recreation services such as daytime or weekend visits to sites that offer a uniform range of services. These conditions generally do not apply to Canadian national parks (see TN 31, 38, and Reference 18.)

While the US Federal Agency procedures appear to be the most useful method at this time (1970), and so will be used in this study, it is recommended that they be modified in three ways. Changes in prices since the technique was developed should be taken into account. Changes in relative prices, which have tended to place a higher value on outdoor recreation relative to general price changes should also be taken into consideration. Finally sensitivity of the benefit (in the eyes of the user) to travel distance should be taken into account. Recommended values are set out in Table 1.

3. Benefits of Economic Stimulation from Tourist Spending

The economic benefits of tourism derive from expanded economic activity which occurs as a result of transfer, by tourists, of spending power from one region to another. A tourist is considered a visitor from outside the region. Obviously, from the local point of view, this would include everyone not normally residing in the immediate area. From the provincial point of view, this means anyone who comes from outside the province, and from the national point of view it means anyone who is not normally resident in Canada.

The requirement therefore for the measurement of benefits from tourism is to discern the level of spending within the region for which the analysis is being made, and which is attributable to the existence of the park. Because tourist expenditures are of considerable economic significance to all provincial governments and to the federal government, well designed studies have been carried out. These reveal average levels of tourist spending which make possible reasonably precise estimates of purchases of accommodation, food and fuel, and which will provide an estimate of gross expenditures by tourists attributable to a national park. It is necessary however, to estimate expenditures net of interregional flows, that is, net of the purchases of goods and services imported from outside the region in question. As in the case of opportunity cost calculation, input-output models which show the linkages

TABLE 1

PROPOSED VALUES FOR RECREATION USE
OF CANADIAN NATIONAL PARKS PER VISITOR DAY

Activity	Representative Park		Unique Park	
	Local Point of Origin	Distant Point of Origin	Local Point of Origin	Distant Point of Origin
1. Picniking, driving for pleasure, highway observation, general use of intensive areas	$1.00	$1.00	$1.00	$2.00
2. Overnight camping	1.50	1.50	1.50	3.00
3. Skiing, golf, guided tours, etc.	1.50	3.00	1.50	6.00
4. Hiking, mountain climbing, canoeing, nature observation, etc.	2.50	5.00	2.50	10.00

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between firms producing goods and services purchased by tourists and firms outside the region will provide an indication of the extent to which the economy of the region will be expanded by tourist expenditures.

4. Benefits of Economic Stimulation from Government Expenditure

Expenditures by the federal government for capital works and operation of a park are costs and not benefits to the national account. In the provincial context, however, such expenditures represent a transfer of funds into the region and a consequent expansion of the provincial economy (directly, through linkages created, and through the multiplier effect). This transfer is net of federal taxes paid for the establishment of the park by residents of the province, and net of money which drains out of the province for goods and services purchased outside. Money transferred into a region to meet opportunity costs cannot, of course,

be counted as a benefit since their effect is to compensate for opportunities foregone.

PRESENTATION OF ACCOUNTS

1. Present Value and Discount Rates

To compare costs and benefits, all values must be expressed using uniform units of measure. This is normally achieved by discounting all costs and benefits to their present value. Present value is the amount that would now have to be invested at a given interest rate (or discount rate) to yield a given amount at a given future date. There is no practical way in which to choose a single discount rate suitable to all purposes. The discount rate is a function of fiscal and monetary policy, anticipated price changes (inflation) and a net amount which is sometimes described as the real cost of capital. This last, in simplest terms, represents the degree to which present consumption is construed to be preferable to investment for the production of future values. For some years, it has appeared that this figure in Canada has approximated 6 percent. This figure is only useful if prices and values are assumed to remain constant for the entire discount period and that fiscal and monetary policy do not shift the discount rate.

The federal government's choice of a discount rate must take into account counter-cyclical spending requirements, current cost of money, and inflationary trends. The province must take the same thing into account, but capital rationing is ordinarily more stringent because of the province's lack of authority to change monetary policy. Consequently, the province will tend to use a higher interest rate. The private individual's discount rate will be highest of all, as he usually has the least control on the money market and the least borrowing power.

2. Presentation of Accounts

The benefit and cost estimates for a proposed park are presented finally in a set of accounts, which is reviewed usually at both the federal and provincial levels, and possibly at the local level. Estimates cover a fixed period, probably 20 years. Since the benefits can be expected to vary from year to year, it is advisable to present an estimate from the provincial point of view and from the national point of view for each year within the planning horizon: 20 separate sheets for each of the 20 years.

PART II

A CASE STUDY: EVALUATION OF BENEFITS AND COSTS OF THE PROPOSED GROS MORNE NATIONAL PARK, NEWFOUNDLAND

THE PARK AND ITS ECONOMIC MILIEU

1. The Park

Gros Morne is the second national park in Newfoundland. It is located in an area of outstanding scenic and natural features, and so is considered a unique park. It is out of the main stream of tourist traffic and is rather remote and difficult of access. Therefore it is forseen that it will receive low intensity use.

2. The Local Economy

According to the 1966 Census of Canada, the proposed boundaries of the park enclose 4,834 residents in four major community complexes and several smaller communities, mostly fishing and ports. These comprise about 1,000 households. 2,388 persons fall within the category 15 to 64 (employable age). The high birthrate and a significant out migration of young adults accounts for the high proportion of dependants. Personal disposable income per capita averages $860 a year, 45% of the national average. Of this, 25% was derived from government transfer payments and 75% from wages, salary and self employed income. 33% of persons are employed in fishing. Their net income is about $619 a year. Average income per capita is increased by the presence of 76 professionals (nurses, teachers and doctors). There is also a high rate of government employment in such activities as road maintenance and ferry operation. The area is in general economically depressed with residents supplementing their cash income by cutting stovewood, hunting and subsistence agriculture.

COST ESTIMATES

Discount or interest rates of six and ten percent are recommended for federal and national costs, while eight and ten percent are the recommended rates applied to provincial costs. The time horizon of the study is 20 years. It is recognized that since a park is establised in perpetuity, many of the benefits and costs will be in perpetuity. Little certainty can be attached to estimates into perpetuity however, so a definite period is selected. Constant dollars are used in calculations. Relative price changes are, however accounted for.

1. Opportunity Costs

Park policy requires that all commercial resource exploitation in the park be discontinued. Because of the importance of fishing, and the possibility that it will be permitted to continue, it will be considered separately.

The other opportunity costs are for foregone timber harvest, agriculture, and mineral development. Although the fuelwood harvest is of declining importance in Newfoundland, it provides a revenue in kind to low income residents of the area, and is almost free when cut from areas adjacent to the park, so discontinuing the fuelwood harvest would not be a loss to the provincial economy. It would however cost the local residents a net of $109,456 a year to replace the wood they harvest. Newfoundland imports lumber, and so the $42,300 which it would cost to import lumber to replace the product from the park area's 22 sawmills would be a cost to the region and the province. There is no loss to the national account because forest products could be manufactured in other parts of the country. The cost to local residents of replacing the products of subsistence agriculture would be about $24,000 each year. This would be a loss to the province which is an importer of food, but not to the nation, where an excess exists. No information exists at this time concerning specific mineral occurrences or income in kind derived from hunting.

A total of 254.5 square miles is held by private companies or individuals under lease or mineral concession. To the owner of the rights, the value of his holding is the present value of the annual net profit which can be obtained by using the land. There is not enough information available to assess the potential profits, so a value of $1.00 an acre is assumed for each year. This results in a present value, discounted at 8%, of $1,599,500. This is a cost to the provincial account, since, in order to conform with National Parks policy, the province must transfer the land to the federal government free of all encumbrances. The province must therefore either purchase privately owned lands and rights, or exchange them for comparable holdings elsewhere.

2. Capital and Operating Costs

Gross capital outlay of the federal government over the 15-year period estimated for the establishment of the park is $27,556,000 for a present value of $21,427,100 discounted at 6%. Salaries, equipment, and supplies necessary to operate the park would amount to $14,123,900 at present value discounted at 6%.

Capital and maintenance expenditures on such things as access roads outside the park are constitutionally the responsibility of the province. Upgrading the access road would be a cost to the provincial treasury of $8,000,000. The province would be relieved of the cost of maintaining roads within the park however, so the present value of the net cost to the province would be $4,724,400 discounted at

8% over the 40-year write-off period. Basic costs are set out in Table 2, Part A.

3. Park Boundary Alternatives and Dislocation Costs

Present National Park policy prohibits permanent communities within new national parks. Because of the number of communities in the maximum extension of the park boundary, three alternative boundaries were considered which leave certain groups of communities outside the park. In all cases, some communities will require relocation.

Under the terms of the agreement signed by Canada and Newfoundland to consolidate communities, relocation grant levels have been established, some of which are shared equally by both governments. The community consolidation program is voluntary, of course, but the costs and grants would not be less for the compulsory program suggested here, so these costs and grants are used for estimating purposes. They include: $1,200 paid to each household, $200 to each member of the household, $3,000 for the purchase of a serviced lot, $500 for moving a house, or $9,000 to replace one that is not in good enough condition to move, clean-up costs for remaining structures estimated at $250 for a household and such additional costs as $25,000 to replace each classroom and $28,000 to replace each hospital bed.

If commercial fishing were permitted, it is assumed that dislocated fishermen would move to neighbouring communities and no disruption of the fishing industry would occur. Disposable income would merely be distributed elsewhere. The provincial economy would not lose this. The loss in real property value and decline in business to merchants who would have to relocate is also included in the cost estimates. Table 2, Part B, outlines the dislocation costs of including the three alternative areas in the park.

4. Implications of Prohibiting Inshore Fishing

It was proposed to include an aquatic zone in the park extending approximately three miles off shore. This would have the effect of prohibiting commercial fishing. As fishing is the principle occupation of primary industry of the area and much of the secondary economic activity depends on it, the alternative of permitting inshore commercial fishing was also considered.

Prohibiting fishing inside the proposed aquatic zone would drastically erode the entire economic base of a high proportion of the communities of the region. Therefore, two of the boundaries considered above are not real options because prohibiting fishing would force those excluded villages to be relocated in any case.

The total annual opportunity cost to the national economy of the fishing harvest that would have to be foregone is $323,380. The loss to the provincial economy would be $389,680. Prohibiting fishing would also entail paying fishermen 50% of the replacement value of their

equipment (50% payment is the practice set in the establishment of previous parks). The gross cash payment, a capital cost to the park, is $158,581. Table 2, Part C summarized these costs.

ESTIMATED BENEFITS

1. Benefits of Preservation

These do not create measurable or tangible economic benefits and so an explicit or monetary equivalent of these benefits cannot be provided (for a contrary view, see Reference 35).

2. Benefits of Recreation Use

To measure the benefits of recreation occuring to park visitors, the number of visitor days in the first twenty years of the park's operation were estimated, divided into categories of activities participated in, and multiplied by the value imputed to each activity by the modified U.S. Federal agency procedures. (For the categories of activities and values, see Table 1.)

In 1968, 269,000 Newfoundland residents used Terra Nova Park (the other National park in Newfoundland). Although park use had grown very rapidly since the establishment of Terra Nova, it was reasonable to assume that growth would stabilize after 1968 at about 5.5%, based on patterns of growth at similar parks when first established and after several years. 1976 was taken as the year that Gros Morne would become fully operational (assuming the park was established in 1972 and took five years to develop and publicise). By 1976, it is estimated that there will be 413,404 visitors from Newfoundland to the two parks. Examination of the amount of increase absorbed by other new parks located near established parks (Elk Island, for example) suggests that about two-thirds of the increase will go to Gros Morne, so that by 1976, 92,000 visitors can be expected. By extrapolating back to 1972 and by assuming a growth rate after 1976 of 2.76% a year (set low to reflect low incomes and low population growth in Newfoundland compared to the national average), it is estimated that 18,900 persons will visit the park in the first year (representing 23,920 visitor days, based on an average stay of 1.3 days for a visitor observed in Terra Nova park) and 138,404 visitors (179,925 visitor days) in the twentieth year.

Off-island visitors to Newfoundland parks must travel long distances at great expense to reach them. Gros Morne park can therefore be likened to parks in the Yukon and Alaska that receive relatively few visitors but whose rate of increase of visitors is very high (about 12% a year). In 1968, off-island visitors to Terra Nova park totalled 23,500. Applying the 12% growth rate, there will be 65,000

TABLE 2

SUMMARY OF COST OF GROS MORNE PARK
PRESENT VALUE IN DOLLARS

National Costs

	6% Discount Rate	10% Discount Rate
A		
Basic Cost	41,341,970	40,293,900
B		
Dislocation Costs		
In all cases	268,350	268,350
Area A	1,388,810	1,301,780
Area B	2,032,680	1,925,670
Area C	5,364,550	5,120,550
C		
Costs of Prohibiting Fishing		
Opportunity Cost	3,709,170	2,753,260
Equipment Replacement	158,581	158,581
Total	54,264,111	51,822,091

Federal Costs

	6% Discount Rate	10% Discount Rate
A		
Basic Cost	35,551,000	33,556,900
B		
Dislocation Costs		
In all cases	55,200	55,200
Area A	277,500	277,500
Area B	368,250	368,250
Area C	1,013,100	1,013,100
C		
Costs of Prohibiting Fishing		
Opportunity Cost	3,709,170	2,753,260
Equipment	158,581	158,581

Replacement		
Total	41,132,801	38,182,791

Provincial Costs

	8% Discount Rate	10% Discount Rate
A Basic Cost	6,974,800	7,301,400
B Dislocation Costs		
In all cases	213,150	213,150
Area A	1,065,410	1,024,280
Area B	1,607,230	1,557,420
Area C	4,221,450	4,107,450
C Costs of Prohibiting Fishing		
Opportunity Cost	3,825,880	3,317,740
Equipment Replacement		
Total	17,257,020	16,957,040

Note: Boundary alternative I would exclude areas B and C from the park, alternative II would exclude only area C and alternative III would not exclude any of these areas. The Total cost of prohibiting fishing would include the cost of relocating all these areas.

visitors by 1976. Because the two parks are no more than one day's drive apart, it is likely that a large proportion of these visitors will visit both parks and so it is reasonable to assume that about 75% of the new visitors will at least visit Gros Morne. This means that in 1976, Gros Morne will receive about 48,000 off-island visitors. Extrapolating as before, and applying the 12% growth rate for the years after 1976, it is estimated that there will be 9,500 visitors in the first year (12,500 visitor days) rising to 267,000 visitors (347,000 visitor days) in the twentieth.

Allocating (on the basis of common sense) the proportion of visitors who would participate in each category of activities and applying the modified U.S. Federal agency procedures, it is estimated that in the first year of operation, imputed recreation benefits would amount

to $68,000, rising to $1,255,000 in the twentieth year. These imputed benefits are not monetized and so have no linkage or multiplier effects.

3. Benefits of Economic Stimulation from Tourist Spending

Every dollar spend by a tourist is a dollar paid to someone else, who will in turn spend part of it on his own consumption or for his business. A part of the original dollar is thus spent and respent over and over. This is the multiplier effect. This effect in the region depends on the amount of each dollar that goes into savings at each stage, and the amount that leaks out of the region for imports. The impact of all tourist spending is increased by the multiplier, as is every expenditure by the federal government for the establishment and operation of the park. It should be noted as well that the tourist industry can have linkage effects in the region.

Although tourist expenditure is clearly expansionary in the region, if it was diverted from some other part of Canada, it has a contracting effect on the national economy so a provincial gain may leave the nation exactly where it was. For the purposes of this study, it has been assumed that any tourist would, if the park had not been established, be attracted to some other facility in Canada.

The value of tourist expenditures, based on visitor rates, is estimated to rise from $70,000 in the first year to $4,900,000 in the 20th year. The multiplier is calculated to be 1.42.

4. Benefits of Economic Stimulation from Government Expenditure

Capital costs of constructing facilities within the park, and the operating costs, while entered as a cost in the national account, constitute a benefit to the province. This benefit is net of tax payments to the federal government (estimated at 2 1/2%) and purchases of goods and services outside that province (imports). (This is calculated to be 25% of expenditures). The net transfer will have an expansionary effect on the provincial economy through direct spending and through the multiplier. There are no net benefits to the national account as it must be assumed that funds not used to establish and operate the park would have been used elsewhere, perhaps in some other region. Discounted at 6% and reduced to 72 1/2% because of transfers and tax payments, the capital expenditures are estimated at $15,534,647. At 10%, this amount would be $16,727,852.

Federal operating expenditures are reduced in the same way and are estimated at present value to be $10,239,827 (6%) or $7,600,900 (10%).

COMPARISON OF BENEFITS AND COSTS

Table 3 shows the benefit cost ratios for the park from the national and provincial points of view. From the national point of view, benefits are less than costs, and an annual comparison shows that the benefits would not begin to exceed costs before the 16th to 20th year, depending on the alternative boundary chosen. These benefits, however, do not include any value to be derived from regional development or preservation. It may be that the benefit of preservation could be considered to exceed the difference between benefits and costs. An unfavourable benefit-cost ratio during a short planning period is characteristic of many large-scale projects. Ordinarily, five or at most ten years would be considered the short-term horizon beyond which benefits should start to exceed costs. The park is, however, preserved for use in perpetuity and the probability exists that the benefit cost ratio would be favourable over a longer period.

TABLE 3

BENEFIT COST RATIOS
($000's, present value)

National Viewpoint

	Estimated Cost		Estimated Benefit		Ratio	
	6%	10%	6%	10%	6%	10%
I	42,731	41,956	19,877	12,768	0.46:1	0.30:1
II	44,763	43,521	19,877	12,768	0.44:1	0.29:1
III	50,128	48,642	19,877	12,768	0.39:1	0.26:1
Fishing Prohibited	54,264	51,822	19,877	12,768	0.36:1	0.24:1

Provincial Viewpoint

	8%	10%	8%	10%	8%	10%
I	8,040	8,326	62,840	54,002	7.81:1	6.48:1
II	9,647	9,883	62,840	54,002	6.51:1	5.46:1
III	13,869	13,991	62,840	54,002	4.53:1	3.85:1
Fishing Prohibited	17,257	16,957	62,840	54,002	3.64:1	3.18:1

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From the provincial viewpoint, the benefits of Gros Morne Park vastly exceed the costs, most of which are met by the federal government and thus transfer purchasing power to Newfoundland. New hotel and motel accommodation, restaurants and gasoline stations will be required, and many existing businessess will benefit. However, tourist traffic is concentrated heavily in the summer months, and so this benefit would tend to be seasonal. In many cases, it would probably consist of supplementary family income earned by women and young adults. There are, however, social costs not accounted for, particularly as far as concerns local residents whose lives have been disrupted by the establishment of the park.

COMMENTARY

At the outset of the study, Parks Canada was aware of the inadequacy of the methodologies reviewed by the consultants. Therefore, the consultants were given the objective of reviewing existing methodologies and choosing or developing one which would adequately and comprehensively evaluate the costs and benefits of a park and would be adapted to the unique characteristics of the Canadian context.

They did not realize this objective: in some areas they did not develop their ideas enough. In other areas they were not comprehensive or glossed over problems. They proposed a modified version of the U.S. Federal Agency procedures, but provided no information on the method used to derive the values obtained. Consequently, the report provides no guidance on how to adjust the estimated values in the future, or on how to improve the estimating procedure. They mention the existence of income multipliers, without applying them, and do not deal with employment multipliers at all. Finally, and most seriously, they do not adequately treat the whole area of intangibles, such as preservation benefits or the social impact of a park on a region (dislocation and break-up of communities, unemployment and the qualification of local residents for jobs created by the park, etc.) These intangibles may have a much greater importance than any other considerations in assessing a park. In some research, it may be acceptable to put aside these questions as beyond the realm of economics, but there are researchers who have puzzled with them, and Parks Canada is frequently called upon to make decisions in which these questions play a part. Any methodology which does not deal with intangibles is thus not adequate for Parks Canada's needs.

The responsibility for this shortcoming cannot, however, rest entirely on Hildebrandt-Young and Associates Ltd. At the time of the study project, Parks Canada had not as yet drafted a series of guidelines that would have permitted close supervision and strict adherence to the terms of reference. Had Parks Canada insisted that the

consulting firm hire personnel with sufficient expertise to develop the required methodology, no study would have been done because the answers to many questions still are not known. Doing and analysis that is good for its day and within the allowed budget for the work is all that (in the end) can be demanded from any consultant.

The research undertaken did make a number of substantial contributions to the problem of measuring the impact of national parks. For instance, the analysis of the three most popular methodologies is comprehensive both in its review and assessment. Furthermore, the analysis of quantifiable variables such as opportunity costs (commercial fishing, forestry, agriculture, mineral development potential, etc.) and estimates of benefits (construction, tourism expenditures, etc.) were both complete and enlightening. Lastly, the analysis of the various development plans for the proposed Gros Morne National Park were done in such a way as to facilitate decision-making concerning the most feasible option.

Thus it must be said that, even though the study did not meet Parks Canada's original optimistic expectations, the report is a useful document for planning and policy purposes. The study can serve as a stepping stone toward an understanding of what to do and what not to do in other research projects of this scope and nature.

APPENDIX

ANNOTATED BIBLIOGRAPHY

Brazer, Harvey E. "Outdoor Recreation as a Public Good and Some Problems of Financing." Address Presented before the National Short Course on Elements of Outdoor Recreation Planning. Ann Arbor, Michigan, 10 May, 1968.

Outdoor recreation is a public good only to a very limited extent, therefore it should be offered by government to users at a price equal to the marginal cost that their use imposes. If outdoor recreation has constantly declining average costs (of production) this scheme will not cover all costs, and the remainder may be met either by the government or by a charge for facilities access. Problems of congestion costs are also discussed.

Canadian Outdoor Recreation Research Committee, THE ECONOMIC IMPACT OF PARKS. Federal Provincial Parks Conference, Canada, 1975.

This paper outlines methods now available for the measurement of primary and secondary benefits of parks and the problems associated with these techniques. Estimates of benefits from past studies are included, as is a set of administrative guidelines for undertaking a comprehensive socio-economic impact analysis.

Coomber, Nicholas H. and Biswas, A. T. K., EVALUATION OF ENVIRONMENTAL INTANGIBLES. General Press, Bronxville, New York, 1973.

A review of the state of the art of evaluating intangible benefits and costs associated with the use of the environment. The authors synthesize, organize and criticize those techniques which have been widely used in the past for this purpose.

Davidson, Paul; Adams Gerald F. and Seneca, Joseph "The Social Value of Water Recreation Facilities Resulting From the Improvement in Water Quality: The Delaware Estuary" in Kneese and Smith, WATER RESEARCH, The Johns Hopkins Press, Baltimore, Maryland, pp. 175-214, 1966.

The first portion of the article is an argument for public intervention in the recreation market. The authors feel that this can be justified by the pervasive externalities, the existence of off peak demand that can be provided at zero cost, the presence of option demand, and the phenomenon of

"learning by doing". The second portion of the article discusses the specific problem of how much recreation will be provided by improved water quality in the Delaware estuary. The figure is not quantified monetarily.

Frey, John C. and Gamble, Hays B. "Policy Issues and Problems in Outdoor Recreation", JOURNAL OF FARM ECONOMICS. 49 (5) December, pp. 1307-1317, 1967.

Using Pareto Optimality as the basic welfare criterion, the authors argue that recreation expenditures will achieve maximum welfare only if the pricing mechanism is used. It is pointed out that one of the simplest welfare maximizing criteria is locating recreation areas nearer population areas. In some cases an increase in recreation sites results in a smaller congestion effect which in turn increases recreation at all sites. Finally, they suggest more multi-purpose ventures and advocate joint public-private partnerships for recreation development.

Norton, Virgil J. "Discussion: Policy Issues and Problems in Outdoor Recreation Economics", JOURNAL OF FARM ECONOMICS. 49 (5) December, 1967.

The author differs with Frey and Gamble in arguing that merit and redistribution effects of recreation are too important to advocate policy on the narrow grounds of Pareto optimality. He also notes that present measurement schemes are inadequate for accurate benefit-cost results.

Robinson, Warren C. "The Simple Economics of Outdoor Recreation", LAND ECONOMICS, 43 (1) February, pp. 71-83, 1967.

Robinson argues that outdoor recreation should be publicly provided on the grounds that it is a merit service. However, it is a merit service not for distributional reasons but as a result of social judgments in favor of a type of quality control that will not be provided by private markets. Since the merit service is not re-distributional in nature, it can be priced. The optimal pricing mechanism can be established in the short run by setting marginal cost equal to price while employing taxes or subsidies on complementary goods to adjust demand to the designed capacity of the facility. Other rationing and pricing schemes are also considered.

Schmidt, Allan A. "Economic Analysis of Water Resource Problems: Non-Market Values and Efficiency of Public Investments in Water Resources", AMERICAN ECONOMIC REVIEW. 58 (2) May, pp. 158-168, 1967.

A general review of the problem involved in measuring "intangibles". Schmid argues that all goods can be priced as they are implicitly priced whenever a decision is made regarding them. Following this point is a suggestive and non-technical discussion of public goods, externalities, and non-marginal change. Externalities and public goods are problems involving property rights. Many environmental goods constitute new products and thus present problems of non-marginal change and price adjustment throughout the economy.

EVALUATION OF THE IMPACT OF THE CREATION OF A NEW NATIONAL PARK: A LONGITUDINAL STUDY

J. Beaman and L. Lehtiniemi

ABSTRACT

The creation of a national park has long-term effects upon the physical and social environment in which it is located. Responsible expenditure of public moneys dictates that efforts be made to maximize beneficial outcomes and to avoid the adverse effects of park development. Officials responsible for the establishment of parks should rely upon whatever tools are available for predicting the consequences of decisions taken.

This paper examines the use of economic impact studies by the creators of National Parks in Canada. First, the role of economic impact analyses in the sequence of events that has recently been typical of the creation of new national parks in Canada is sketched. Next, references reflecting the state of the art are noted and two types of impact assessments are distinquished. A case study representative of the two types is presented, showing how and why the events that actually took place in developing a specific national park differed from what had been predicted.

The paper suggests how, in the light of Parks Canada experience, economic impact studies can be refined and improved, and the role they should play in future park development.

INTRODUCTION

The creation of a national park has long-term and in many ways irreversible effects upon the physical and social environment in which it is located. Responsible expenditure of public moneys dictates that efforts be made to maximize beneficial outcomes and to avoid adverse effects of development of a park. Officials responsible for the establishment of parks should therefore rely upon whatever tools are available for predicting consequences of decisions taken in the present.

Although proven techniques for assessing the impact of developing a major park cannot yet be claimed, progress is being made. Some aspects of this progress are clearly documented in this volume. This paper not only cites these developments but points up some interesting results of studying an area from before a national park was created (1964) until the park was in full operation (1973).

It is by detailed analysis of what happened with respect to one park in particular that this paper frankly examines the use of economic impact studies by the creators of national parks in Canada. The role of economic impact analyses in the sequence of events that has recently been typical of the creation of new national parks in Canada is first described for those not familiar with it. However, the main thrusts of this presentation are directed toward suggesting how, in the light of Parks Canada's experience, economic impact studies can be refined and improved. Possibly of even more importance are reflections on what role such studies should play in development of new parks from conception to implementation and operation.

THE ROLE OF ECONOMIC IMPACT STUDIES IN THE PROCESS OF CREATING A NATIONAL PARK

The creation of a national park in Canada involves bilateral negotiations between the Federal and Provincial levels of Government. The Federal Government desires to realize certain national objectives in developing a national park. Because the Federal Government ultimately requires title in fee simple to the land that will become a national park, and the land must be transferred to it by the province free of any encumbrance, a strong bargaining situation arises. Provincial Governments, in exchange for granting title and relinquishing the right to resources within the park, seek to ensure that proposed parks are compatible with and will enhance regional growth and development within the province, or help attain some other provincial objectives. It is within such a context of intergovernmental relations that economic studies of proposed national parks are conducted.

The sequence of events related to creating a national park involves definable phases (see Figure 1) and normally extends over several years. The first step of relevance to this discussion consists of the preparation of a concept plan that outlines in general terms where the park will be located, something about its size, the features to be highlighted and the type of development to be undertaken. This plan may involve only one or several options for the development of a park. Although it is customarily the Federal Government which prepares the plan, the process of concept plan formulation is dynamic, characterized by discussions and "tailoring" of the plan in the interests of producing an end product that appears viable and mutually desirable.

It is only after the discussion of the concept plan has evolved to a certain stage that an economic impact assessment is normally comissioned to evaluate the viability of implementing the plan(s). At this stage an economic impact study is used to determine if or on what basis a park proposal should be moved beyond the concept plan stage. In such a study one evaluates what is only, in fact, an outline

of what might be. Given that many details may be modified prior to final development of the park, it is necessary to deal with approximations. Because the analyst is charged with evaluating the impact of a development as outlined in the concept plan, the effects of deviations from that plan or the effects of exogenous influences not considered in the study are seldom pursued.

FIGURE 1

THE SEQUENCE OF EVENTS IN PARKS DEVELOPMENT

1. Proposal for a Park Considered Internally.

2. Bilateral Negotiations Begin.

3. Preparation of the Concept Plan for the Park.

4. Economic Impact Assessment of the Proposed Park.

5. Evaluation and Reaction to Economic Impact Study.

6. Agreement in Principle to Create the Park.

7. Preparation of Master Plan for Park Development.

8. Development of the Park.

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If a proposal to develop a park is judged to be viable on the basis of the economic impact assessment, formal negotiations between the governments involved will proceed and possibly pursue new development alternatives before an agreement in principle is reached. During this process, it is likely that the decisions and compromises made will modify some aspects of the original concept plan. For example, if both parties do not concur about the viability of the proposed park, the negotiations could involve appropriate land transfers or other compensation to promote agreement.

After a formal agreement to create a park has been struck, detailed planning commences, carrying a high potential for further modification of the concept plan upon which the economic impact analysis of a park was based. In this regard it should be noted that there is no mechanism to ensure that the final design of a park adheres closely to the concept plan on the basis of which the park was judged to be viable. The consequences of changes may become evident only after the park is developed.

ECONOMIC IMPACT STUDIES

With respect to the work done for Parks Canada, two types of economic impact analyses can be distinguished. The type that has usually been employed in evaluating proposed national parks in Canada consists of a single predictive assessment of the outcome of developing a park (see TN 39 for one example). Among these a priori studies there can be wide variation in the approach to evaluation. Some focus on secondary benefits only, others attempt to include an evaluation of the primary benefits to future park users. The accounts prepared (local, regional, provincial) and the degree of detail and comprehensiveness of these studies are variable. Details are not provided here because many of the studies prepared relate to park proposals still under consideration.

The state of the art of impact assessment to 1970 has been summarized for Parks Canada as part of an evaluation of the proposed Gros Morne National Park in Newfoundland. (Again see TN 39 and relevant introduction and review material for Chapter VIII.) In this report Hildebrandt-Young (see Reference 27) reviewed techniques used by others and available to those conducting economic impact analyses. Their bibliography includes more than 160 items which deal with public finance and economic problems of national park development. The Coomber and Biswas monograph "Evaluation of Environmental Intangibles: Review of Techniques" (see Reference 18) prepared for Environment Canada provides a complementary review which focuses almost exclusively on primary benefits.

In constrast to a priori studies are those which examine the consequence of creation of a park after it is in operation. These analyses measure what really happened as a result of developing a park and compare actual outcomes with what had been predicted in an a priori study. Apart from the timing, such studied are similar to predictive studies in terms of the variations possible in scope, details and comprehensiveness. However, findings from follow-up economic impact assessments can suggest how predictive models might be improved. The only follow-up study of the impact of creating a National Park in Canada to date is that of Kejimkujik National Park, which is reviewed in some detail here.

THE KEJIMKUJIK STUDIES

In 1962 an area approsimately 150 square miles surrounding Kejimkujik Lake in southwestern Nova Scotia was proposed for development as a national park. As one stage in the creation of the park an a priori study was commissioned to assess the economic impact of the park on the area judged to be within normal commuting distance to the park for reasons of employment. The objectives of the Economic Survey of the Kejimkujik Park Area (see Reference 28, 29) were to

(a) provide bench-mark data on the economic conditions of the area to enable comparison with future conditions resulting from a change in resource use, and (b) to determine the economic justification for a specified change in resource use (i.e. for the establishment of a national park) in terms of the total benefits to be derived relative to total costs.

The study did provide income, employment and property values as parameters of economic conditions, and a methodology for reassessment of these at a later date. However, without having attempted to measure the benefits of creating a park, but having suggested procedures that might be employed in doing so, the report concludes with a favourable "estimation" of the prospects for success of the park as an economic stimulant. In terms of how the authors of this paper suggest an evaluation should proceed, the study would be harshly critiqued. It should be borne in mind, though, that the study was carried out in 1964, and methods for impact analysis have improved since then.

Regardless of the shortcomings of the formal study, the history of the development of Kejimkujik serves to point up how and why even a rigorous, expensive and thorough analysis might have failed to predict what has happened there. In this regard one should note that no control mechanisms existed to keep park development on the right "trajectory" to fulfill and realize the expectations for the park that had been expressed in the concept plan.

After agreement in principle had been reached, a Master Development Plan was formulated in 1965 to delineate facility location and development zones within the park. The plan was based on an expected volume of visitor days and a number of rental accommodation units to be available outside the park boundaries by 1970. The volume-of-use estimate was based on use figures for the three existing national parks in the Maritime Provinces. It was assumed that the origins of visitors to Kejimkujik would be similar to those of visitors to Cape Breton Highlands National Park which is in the opposite end of Nova Scotia to Kejimkujik (see Figure 2). Moreover, it was assumed that Nova Scotia residents would use the new park as much as New Brunswick residents used Fundy National Park. By considering these factors, a need for 1000 campsites within the park was foreseen. The need for much private sector accomodation outside the park was accepted. Unfortunately, details on the basis for estimating accommodation requirements are not known.

Kejimkujik National Park was officially opened in 1969, four years after the first master plan was prepared. Although the master plan was based on an estimate of 210,000 entrants by 1970, the actual use volume in 1971 was only about 150,00 visitors. The number of campsites that had been developed by 1971 was only 330, less than one third of what had been planned.

Because of a Parks Canada moratorium on campground development in the park, 330 sites was not to be exceeded in order to encourage campground development near the park by

the private sector. However, even in 1973, the Park's 330 campsites seldom reached 75 percent occupancy on week days. Admittedly on weekends in July and August the park's campsites were usually filled to capacity. Turning away potential users was often a problem. Still, it is interesting to note here that although the Kejimkujik campgrounds are usually full by 9 p.m. Friday evenings, one private campground just outside the park has only "reasonable" occupancy on "some" weekends. Other major campgrounds in the area are used mainly on weekends, but these have their own resource base and cater to people who reserve sites on which to park trailers for the whole summer.

The characteristics of visitors to the Park are quite different from what had been expected. Nova Scotia residents constituted more than 69 percent of all park users in 1973, whereas it had been predicted that they would amount for approximately one third of the visitors to Kejimkujik. In contrast, residents from the other Canadian provinces accounted for only 11 percent of the users; much less than the 33 percent that had been expected. From the perspective of "user-days", Nova Scotian and other Canadians represented 67 and 13 percent respectively of the total for the Park. Lastly, it should be noted that just less than one half of all visitors to Kejimkujik National Park in 1973 were day users.

Five years after the opening of the park, and while the events just described transpired, the Institute of Public Affairs (see Reference 29) conducted a second study to measure the actual socio-economic impact of the park on the local area. The study replicated in part the surveys carried out in 1964. Comparisons were made of income and employment before and after creation of the park. However, an assessment of property values was not repeated in the follow-up study, although changes in property value have been recognized as important in determining the impact of such developments (e.g. see Reference 29).

The 1974 Kejimkujik National Park Socio-Economic Impact Study (see Reference 29) concluded that the park had not been a major generator of regional economic growth. It makes it very clear that the park did not have the developmental impact initially anticipated. The study reports that, as of 1973, the park provided direct and indirect employment for 113 people,(83 of whom were part-time workers) In the assessment, the loss of 33 part-time jobs at tourist facilities which were closed as a result of the park is recognized, but the 1974 review does not include estimation of foregone employment from the forest industry in computing the net employment benefits, nor does it acknowledge the loss of use of the land for hunting and trapping.

What is more, it is not emphasized in the follow-up assessment study that only 17 of the 30 full-time jobs and 22 of the 48 part-time positions which constitute the net employment effects were filled by local residents. The skilled workers used to administer the park and many of its

programs were imported from outside the Region. Still, the report does conclude that the large number of part-time jobs at the park does not make for a stable economic climate, but no indication is given as to what increase or decrease in stability resulted from developing the park.

The net income impact of the park in 1973 was estimated as $384,295, using the income multiplier of 1.108 derived in the 1974 follow-up study. But one should note that in calculating the impact and the multiplier, the wages paid to employees who were brought in from outside the area as park staff by Parks Canada are included. It might have been more appropriate to include only the local expenditures of these "imported" employees when computing the regional benefits of creating the park.

Inclusion of a consumer surplus value per visit by Nova Scotia residents in 1973 raises the amount of benefits to the province for that year by $693,000 when conservative estimates of consumer surplus values are used (see TN 38 for Canadian consumer surplus values). The computations used to derive this primary benefit value are shown in Table 1.

TABLE 1

CALCULATION OF PRIMARY BENEFITS
TO NOVA SCOTIA RESIDENTS
USING KEJIMKUJIK NATIONAL PARK

Type of Use	Number of Users (persons)[1]	Consumer Surplus Value[2]	Primary Benefit Value($)
Day use	23949	5.00	119745
Overnight use	4839	9.00	43551
Camping Trip	15136	35.00	529760
			693056

1. From Park Visitor Survey, 1973.
2. Adapted from values in Table 1, TN 38.

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Lest an unfavourable impression about the wisdom of creating Kejimkujik arises, some additional comments merit attention in passing. Although the economic assessment did not consider primary benefits, analysis of the characteristics of users of the park has shown that almost 70 percent of the visitors are residents of the province. Moreover, the development of Kejimkujik retains in the province the expenditures of those Nova Scotia residents who would otherwise travel out of the province to seek the type of experience that the park offers. Finally, neglecting to consider 1973 property values in the area with respect to

real capital gain resulting from development of the park is only part of a failure to consider the gains derived from creating a park in 1964 that is sustaining employment in the local area and which now serves as an important element in developing the tourist potential of southern Nova Scotia.

SUGGESTION FOR IMPROVING ECONOMIC IMPACT ANALYSIS

It should be obvious that the studies of Kejimkujik were not reviewed as examples of research that should be used as models of how to analyze the impact of proposed parks. Also the other CORD Study impact analysis is not endorsed as a model to follow in doing other analyses (see TN 39). The case of Kejimkujik was presented because it is not typical of socio-economic impact studies of National Parks in Canada in one important respect - it involved a follow-up assessment of the impact of the creation of a major park. Having that salient feature, it serves as a springboard to a more general discussion of such studies and how these should be refined.

Two main thrusts are suggested as necessary in improving studies. One involves advancing the state of the analysis art and thus enhancing the quality of assessment studies. This is desirable in its own right, even if the function served by impact studies remains unchanged. The other thrust, which the authors believe the "Kejimkujik" and other studies show is necessary, entails promoting a closer and continuing interplay between the persons doing the impact analyses and the park planners and developers. The objective is to promote longitudinal assessments throughout the process of park creation and even until after the park has been developed. Naturally, efforts should be made to integrate the two types of improvements.

The sequence of steps shown in Figure 3 relate to the first of the two thrusts just cited - namely, ensuring high quality in economic impact studies. The first two steps involve clarifying and articulating the objectives of a park and thereby making more specific the development options to be considered. The statements in the figure suggest that it would be important early in a study to identify the expected relationships between park development and activities in the private sector. The third step consists of delineating what economic and social elements should be included in the socio-economic study accounts to measure the extent to which the objectives delineated in step 1 are attained. Although professional judgement, the prerogative of the client and the peculiarities of each situation will always be deciding factors regarding what is included, it is suggested that a general checklist of elements that should be considered in any socio-economic impact analysis would be helpful. Such a list would serve as a focus for discussion between the analyst technically responsible for an impact study and the "user client".

The remaining steps listed in Figure 3 relate directly

Figure 2

Recommended Steps in Preparation of an Economic Impact Assessment

1. Identification of Objectives of Park Creation.
2. Specifications of Development Options of Concept Plan.
3. Delineation of Economic and Social Aspects to be Studied.
4. Selection of Base Data re: Use, Expenditures, Multipliers, etc.
5. Definition of Projection Procedures to be Used to Generate Data Required to Estimate Future Impact.
6. Preparation of the Accounts by which the Concept Plan or Development Option will be Evaluated.
7. Specification of the Likely Magnitude of Error or Expected Range of Variation of Various Impacts.
8. Preparation of a Longitudinal Evaluation Plan that Identifies Critical Indicators to Monitor, and their Predicted Values and Acceptable Range of Variations, for Ensuring that Economic Objectives of Developing the Park are Attained.

to the accuracy of impact assessments. Their importance has become apparent from Parks Canada's experiences, some of which are cited in the next section, and from work done as part of the Canadian Outdoor Recreation Demand (CORD) Study.

Probably the most important thing to note is that the final step suggested in Figure 3 involves creating a mechanism to promote continuing assessment of the impact of each modification to the concept plan during the possibly protracted process between first consideration of a park and its being in operation. The identification of critical indicators to be used in evaluating modifications could be the necessary tool to use in exerting the strong pressures needed to keep park development consistent with the objectives that were sought through its creation. In this regard one should note that many impact assessment studies have been unfairly judged in retrospect because they were based on a concept plan which was extensively transformed after the studies were completed. Preparation of a longitudinal evaluation plan also leads to a redefinition of the role of impact assessment studies in the process of park creation, which is the second thrust to be considered in this presentation.

Figure 4 presents headings and a flow sequence which aid one in seeing how the process of creating a park might be elaborated to include a continuing relationship between impact forecasting and facility planning and development. It is characterized by feedback loops which suggest the necessary evaluation of the effects of implicit or explicit modifications to the concept plan of a park at various stages in the creation of a park. The first feedback loop relates to assessing the consequences of any major changes that result from the bilateral negotiations prior to signing a formal agreement, and identifying what effects these changes may have upon the accounts prepared in an original economic impact study. This reassessment would logically precede finalization of an agreement. The second feedback loop is included to focus on the need to ensure that the Master Development Plan is consistent with the objectives of creating the park. In practical terms it points up the need to form a linkage between the policy management functions of park acquisition and the planning functions within an organization. Finally, the figure implies that if a park is to attain objectives set for it during a negotiation process a monitoring process must be introduced to ensure that the effects of modifications to the Master Development Plan are evaluated and that such changes are consistent with the desired results of creating the park.

In addition to building in an on-going evaluation process to detect potential unanticipated impacts, a follow-up economic impact assessment when development of the park has been completed is implied as desirable by the plan shown. This study would be valuable even though a longitudinal assessment procedure was introduced to document unanticipated effects and to point out what improvement in

FIGURE 3

RECOMMENDED STEPS IN PREPARATION
OF AN ECONOMIC IMPACT ASSESSMENT

1. Identification of Objectives of Parks Creation.

2. Specifications of Development Options of Concept Plan.

3. Delineation of Economic and Social Aspects to be Studied.

4. Selection of Base Data Re: Use, Expenditures, Multipliers, etc.

5. Definition of Projection Procedures to be used to Generate Data Required to Estimate Future Impact.

6. Preparation of the Accounts by which the Correct Plan or Development Option will be Evaluated.

7. Specification of the Likely Magnitude of Error or Expected Range of Variation of Various Impacts.

8. Preparation of a Longitudinal Evaluation Plan that Identifies Critical Indicators to Monitor, and their Predicted Values and Acceptable Range of Variations, for Ensuring that Economic Objections of Developing the Park are Attained.

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impact could be facilitated by future park development.

DISCUSSION

Actually, the variables being considered and the kind of equation systems being developed to define use at a given point in time (base figures) and to make projections gives one an insight into the problems involved in making reliable use estimates and realistic projections. Figure 5 lists some of the exogenous and endogenous variables that are relevant in predicting the dynamics of the development of Kejimkujik National Park. There was no attempt to be exhaustive in making the lists but rather a variety of variables were identified (see Appendix). In the Appendix, the variables listed in Figure 5 are discussed to provide an indication of why and how these variables are relevant to the Kejimkujik Park development.

Regardless of the complexity involved in stating a specific set of equations to model park use, by looking at

FIGURE 4

A PROPOSED ROLE FOR SOCIO-ECONOMIC IMPACT STUDIES IN THE PARK DEVELOPMENT PROCESS

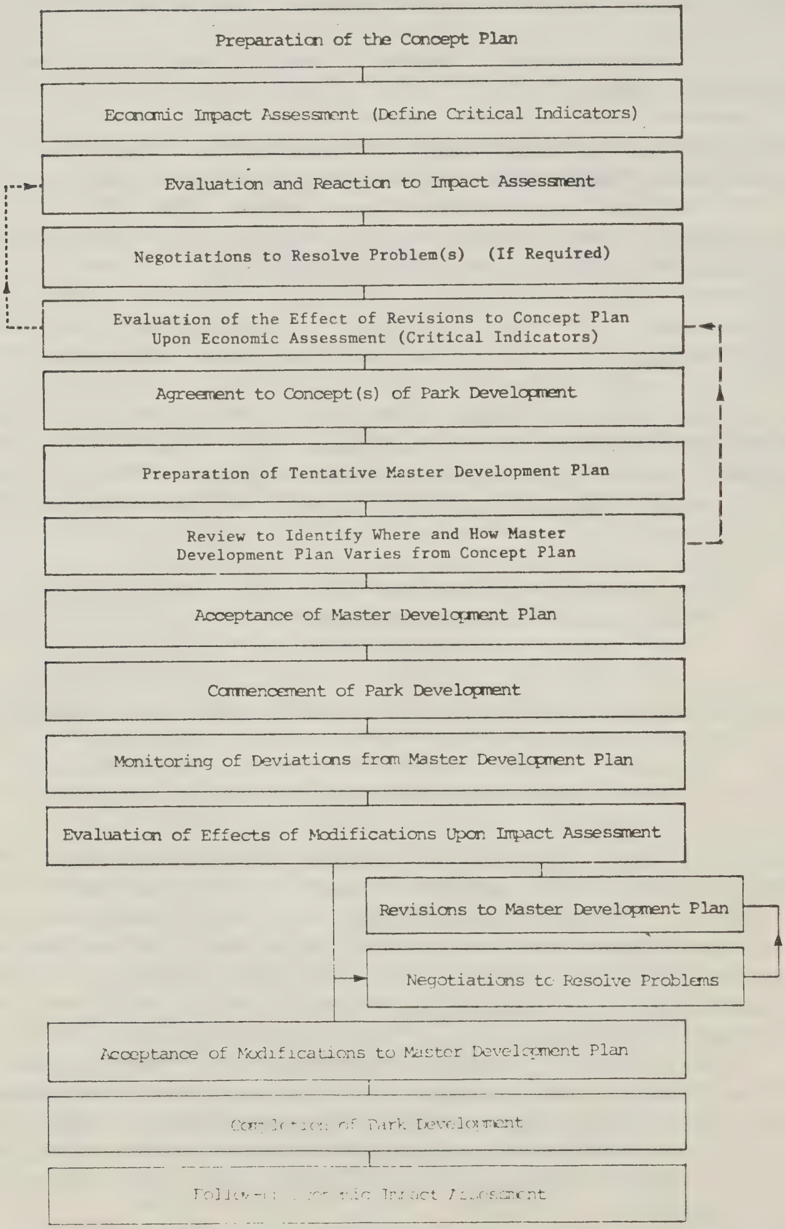

Figure 6 one can get a fairly clear picture of the kinds of relations between variables which are seen to be of concern by Parks Canada. The flow chart in this figure shows the "directions of causality" implied by events that have been observed by Parks Canada.

In particular one may note that Figure 6 shows that a change in an exogenous variable from series 1 of Figure 5 results in a change in one or many of the classes of use of a park (series 3 of Figure 5). The structure of the figure then suggests that changes in use levels operate to influence the development of new facilities or the modifications of old facilities to meet use demands. As well, the structure of the flow chart implies that the modifications feed back to affect the amount of use of facilities just referred to (series 2 variables affecting series 3). Similarly, use causes the development of roads and thus development feeds back to cause use. The ultimate desirability of considering the lead-lag factors that affect reaching an equilibrium is admitted but the problems involved are not pursued here.

A third series 2 variable (2.3 of Figure 5), which is somewhat different than the preceding two, is the class of crowding variables. Here the situation implied by the way Figure 6 is drawn is that increased use causes changes in crowding, but that as well, facility development changes crowding conditions. One could say that a 3-way feedback is implied that results in some kind of an equilibrium between crowding, use and the development of facilities.

Figure 6, by its simplicity, suggests that modelling of park use is much simpler than it is in reality. Figure 7 is presented because by examining it one begins to see the fantastic complexity of interrelationships between variables that must be approximated if structurally adequate models of the dynamics of parks use are to be defined for use in economic and social impact studies.

The concern with adequate approximations has been introduced as an issue because, as one can guess by looking at Figure 7, it is simply not possible, with the amount of data that are available under normal budgetary and time constraints, to develop a set of 40 or more equations (unless Parks Canada over the long run develops a generalized modelling system easily applied to particular problems). Even when the equations indicated are adequately defined, there are problems in carrying out an estimation exercise to obtain the parameters for these equations (see TN 11 and comments on parameter estimation problems that are made there). Actual Parks Canada projects have invariably involved only a few equations and to this point in time have not involved estimation of parameters when capacity constraints are actually enforced on an equation system. There has been a need to be concerned with the limited amount of data available, the quality of data (see e.g. TN 21), the proper form for individual equations (TN 35, TN 33, TN 30, TN 18, TN 1 and TN 3), the use of appropriate and

FIGURE 5

EXOGENOUS VARIABLES

(1,1) The development of Nova Scotia Highways affecting the access to Kejimkujik National Park (independent of the use of Kejimkujik).

(1,2) Level of development of facilities outside the park independent of the park (facilities not even necessarily in Nova Scotia).

(1,3) Creation of a new National Provincial or Private Park independent of the pressures of Kejimkujik.

(1,4) Policy decisions affecting the interest rate on funding of tourism development (e.g. creation of available low interest tourism development funds by the Government of Canada).

(1,5) Weather: (a) series of bad seasons resulting in a change in the tendency to go to the park at all in future seasons (b) weather conditions influencing visiting on a given weekend or weekday.

(1,6) Infestation of pests (causing an undesirable impression of the park which must be overcome in subsequent seasons).

(1,7) National Parks policies such as the "Freeze" on campground development or administration policies affecting the amount and quality of beach and wilderness available or how these areas are used.

(1,8) Population shifts independent of Park creation.

(1,9) National or Regional economic change affecting the disposal income available for trips to parks.

(1,10) Trends which involve drastic departure from past behaviour (e.g. are not explained by trends in past trends).

ACTION ENDOGENOUS VARIABLES

(2,1) Development of new facilities or modification of old facilities to meet user "demand".

(2,2) Development of new roads or imporvement of old roads to meet weekend or weekday park load.

(2,3) Crowding or overuse of: a.activity areas; b.beaches; and c.campgrounds - because of weekdays and/or weekend use.

USE CONSEQUENCE ENDOGENOUS VARIABLES

(3,1) Local weekday use.

(3,2) Local weekend camper use.

(3,3) Other intra-provincial weekday use.

(3,4) Other intra-provincial weekend camping use.

(3,5) Other uses (e.g., beach use or interpretive facilities.

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efficient estimation procedures for single equation models (TN 19) and other issues.

Actually, a number of CORD studies implicitly point out the need for the kinds of use estimation equations referred to in Figure 7 (see TN 1, TN 4, TN 8, TN 18, TN 30 and TN 33). The basis on which the need for these equations is defined, is both by reference to the research of others and by the discussion of specific situations that illustrate why models of a certain type are appropriate to a given situation where it is possible to see that other models are not appropriate.

One should note that the commentary on Figures 5, 6, and 7 has not raised the issue of making projections. Obviously the exogenous variables (series 1 variables of Figure 5) were introduced because they should be part of the input to a set of "dynamic" demand equations. However progress towards developing projection equations has not been in the area of deriving equations systems for individual sites. Effort has focused on estimating aggregate

FIGURE 6

THE GENERAL NATURE OF RELATIONS
DEFINING PARK USE

A change in a variable in the '1,' series of Figure 5 (e.g. 1,1).

Results in a change in some or many types of users. (e.g. classes 3,1 3,2 of Figure 5)

Which relates to the interaction of series 2 variables of Figure 5 (i.e. 2,1 2,2 and 2,3).

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demand by people at various origins (see TN 6, TN 12, TN 13, TN 20 and TN 36).

Parks Canada work on projection of aggregate demand (origin modelling) cannot be described in detail here because there are too many notational complications, estimation problems requiring comment, etc. to allow a brief review to be meaningful. Still one may wish to note that CORD Study research has considered the type of demand models that Knetsch proposed for use (TN 34) and other similar models. The results of extensive research (starting with model formulation in TN 12) have been:

(1) to develop formulas for predicting the accuracy of estimates if a model is structurally acceptable (TN 6),

(2) to show structural problems with the models being considered and suggest solutions (TN 20),

(3) to show the value of R^2 that is to be expected in the kind of modelling being done (TN 36), and

FIGURE 7

DESCRIPTIVE SUMMARY OF EQUATIONS FOR PARK SUMMER SEASON USE OF KEJIMKUJIK NATIONAL PARK

A. USE EQUATIONS[1]

Equation

1. Day-use; immediate local area for weekdays.

2. Day-use; immediate local area for weekend and long weekend.

3. Campground use; immediate local area for weekday (non-extended holiday weekday use).

4. Campground use; immediate local area for weekend days and long weekend.[4]

5.-8. Same equations for holiday use of the park (non-wilderness holiday use).

9.-10. Wilderness use equations; for weekend days (9) and holidays (10).[3]

11.-20. Similar equations for use of park by non-local people who are from rest of Nova Scotia.

21.-30. Equations to estimate use in the same categories by non-Nova-Scotian residents of Canada.

31.-40. Equations to estimate use in the same categories by U.S.A. residents.

B. CONSTRAINT EQUATIONS[4]

41. Managed campground capacity constraint (campground use on a given day cannot exceed capacity).[5]

42. Administrative control of wilderness use.[6]

43. Facility and service capacity constraints (e.g. parking availability for day-use; picnic area capacity constraint[7]; capacity for guided hikes; interpretive films, tours, lectures, etc; and the like).

1. This figure does not explicitly introduce "en route", "main-destination" and other descriptions used in

defining equations discussed or "estimated" in CORD Study research projects. One can consider that a full specification of all possible equations that should be considered would include, for example, en route and main-destination use equations for holiday use of Canadian National Parks by U.S. residents.

2. Independent variables should often include weekday loading and weekday turnover to reflect the space available for "new" weekend use, or these considerations must be built into the constraint equations.

3. The omission of weekday equations means that it is considered that "true" wilderness use of a National Park by a person cannot occur after work on a weekday.

4. As indicated in Figure 6, crowding is not viewed as a constraint. Rather; crowding variables are considered endogenous variables unless crowding control variables are introduces administratively as indicated in Equations 41 and 42.

5. See operations policy directive - on the use of overflow campgrounds.

6. Parks Canada does not presently exert specific controls on the number of users in wilderness areas such as the "controlled" maximum number on a trail that the U.S. Park Service uses at Yosemite National Park.

7. The work presented in TN 16 has been greatly extended by Ontario and includes definitions of capacities for a number of activities.

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(4) to suggest a quantitative projection strategy and problems with this strategy (TN 13).

CONCLUSION

The title of this paper may have been misleading because the two economic studies associated with Kejimkujik National Park were used as a focus for a more general examination of impact assessments of major parks in Canada. The main concern has really been with deficiencies in impact studies and how these may be overcome.

Although numerous papers that offer improvements of models for use estimation were cited, it is not implied that the major methodological problem with economic impact studies of park development in Canada rests with the mathematical and economic models used. The importance of technical references is to communicate the current emphasis in use estimation of differentiating the various types of use that are made of an area depending on how it is developed, and to draw attention to assessment of the accuracy of estimates. Improvements in these technical areas have very practical and obvious applications.

In the view of the authors it is important to stress that the usefulness of economic impact assessments can be increased by redefining the role they play in a longitudinal process. So, in closing, the authors wish to reiterate their view that even if a very "sophisticated" study of Kejimkujik had been carried out in 1964, the results would have proven to be disappointing. Regardless of what methods might have been used to make estimates, there were at that time almost no suitable data available from which to generate use estimates for some base year, nor was there trend information on park use that could have been projected into the future. In addition, much of the methodology now available was developed only after that study. But most importantly the need to build longitudinal follow-up into the impact assessment of park development had not yet been recognized as critical.

APPENDIX

The reader may find it interesting to note why some of the exogenous variables that have been listed (see Figure 5) have been indicated. In particular, he may be surprised to find out that all of these are exogenous variables that have influenced the development of Kejimkujik National Park. Specifically, the extension of a four-lane highway south from Halifax, which has been carried out independently of the development of Kejimkujik National Park, does have a tremendous impact on the accessibility of the park both for people who do not come from Nova Scotia and for Halifax

residents who wish to go to the park.

Development of facilities outside the park independent of development in the park is a catch-all for impacts that could have, or did occur. Certainly one can refer to the development of the highway, cited as 1.1, as falling under 1.2 but a development which is much more in the spirit of what is referred to would have been the development of a new national park which at the time it was being considered was to be called Ship Harbour National Park. Negotiations on this park proceeded to the point of placing a land freeze on the land that was to be used for development of the park and it was only as a result of a great deal of public pressure that the Ship Harbour Park was not created. Had this park been created, the many users of Kejimkujik who come from Halifax would have had a place they could go which was much closer to Halifax and consequently, a drastic shift in the use of Kejimkujik National Park could have been expected.

Exogenous variables 1.5 and 1.6 refer to weather conditions and pest conditions that are well known to users of the Atlantic Region National Parks. Actually, one year in the Maritimes may be lovely then several years of bad weather can serve as a real discouragement to people who make their plans and go away for a holiday, only to end up having 2 weeks of rain. Similarly, the infestations of bag-worms in Kejimkujik National Park in 1973 and 1974 have left many people with an impression of the park that guarantees they will choose to go somewhere else where they will not continuously be wondering if one of these pests will fall from a tree onto them or into the food they are preparing.

Variable 1.7 points up the importance of policy decisions, such as a freeze on campground development in determing what use is made of a given national park. The preceding discussion has pointed out that original plans for Kejimkujik involved 1,000 campsites being built within the park. Obviously a policy decision that has held down the campsite development to 330 campsites has had an influence on the amount of use that has occurred at the park. However, in stating this, one must recognize that the decision to freeze campground development was not an endogenous decision based on lack of use; it was an exogenous decision based on considerations of the best ways to achieve regional development objectives.

Similarly, one can expect administrative policies affecting the amount and quality of beaches and wilderness to affect the use of National Parks. Here again, it is important to note that the decisions referred to are not decisions in response to present use, but management decisions based on considerations external to the particular park.

The variables listed as 1.8 through 1.10 are quite possibly the ones that would have been expected in a list of exogenous variables influencing park use. Though it is obvious that the population shifts, the national and regional economic changes and special transit activities do influence the use of parks, it should be pointed out that it

is not obvious how to build these variables into a modelling framework. This is a problem that has received extensive treatment as part of the CORD Study and Technical Notes on this topic cited in the paper.

THE ECONOMICS AND POLICY IMPLICATIONS OF PRIVATE CAMPGROUND DEVELOPMENT IN NATIONAL PARK CENTRED VISITOR REGIONS: AN EMPIRICAL STUDY

J. Lewis, G. Andrews, T. O'Riordan

ABSTRACT

In Canada, one of the poorly documented segments of the tourism and recreation industry is that of private campground development and operation. In particular, the relationship between the public and private sectors has not been fully examined. This study investigates the viability of National Parks-oriented private campgrounds to provide information that can be used to recommend public policy options.

After a review of the literature, the paper focuses on four eastern parks and the public-private campground mix in and around them. It describes a survey of the operators of forty private campgrounds, the analysis strategy followed, and the results obtained.

PURPOSE

The objective of this study is to investigate the viability of National Park-oriented private campgrounds to provide information for the evaluation of alternative public policy options.

INTRODUCTION

In Canada, one of the most poorly documented segments of the tourism and recreation industry is that of private campground development and operation. In particular, the relationship between the public and private sectors has not really been examined. With the increase in camping pressure over the years, it is now apparent that problems are arising and that questions pertinent to public policy should be investigated to reduce or avoid existing or potential conflict between the public and private sectors. Specific problems include: how to best satisfy the demands of the different types of campers; how to generate the greatest local impact in terms of income and employment; how to avoid the detrimental impact on the viability of certain parts of the private sector; and how should National Park planners, policy makers and managers react to suggestions of expansion, curtailment or differentiation of their

activities (in light of the private sector) in the provision of campground sites and facilities.

LITERATURE REVIEW

General

Camping continues to grow in popularity. In 1967, the Bureau of Outdoor Recreation (see Reference 10) reported a 62 percent increase in camping days by Americans between 1960 and 1965, and projected a 450 percent increase in camping days between 1960 and 2000. However, by 1972 the Bureau noted that the total number of camping days had quintupled (from 66,000 to 354,000) in the decade of the sixties alone and that during the same period, the number of camping days per person had grown from 0.9 to 3.0 (see Reference 10).

Canadian data echo the USA findings. In 1968 a national survey (see TN 22 and Volume III) found that 25 percent of the interviewed sample camped in 1967 campared with 15 percent of those contacted four years previously. A similar survey conducted in 1972 found that in the period 1969-1972, participation in tent camping had grown from 12 to 19 percent, trailer camping from 6 to 10 percent and pick-up camper use from 2 to 4 percent amongst Canadians interviewed. It is particularly significant to note that while participation in camping as an activity has increased there has, in recent years, also been an increase in the number of camping days per person, i.e., individual campers participating in camping have actually increased the number of days that they camp during the camping season.

In terms of the Canadian National Parks system, camping demand has grown consistently at around 7 percent per year for the past 22 years; a doubling every ten years.

The introduction of the recreation vehicle (RV) coincided with important shifts in motivations and expectations toward camping, changes that can be discerned at all levels of the camping experience. While the hardy tenter seeking solitude and a wilderness or quasi-wilderness setting has by no means disappeared, he is finding it more and more difficult to obtain a satisfactory camping experience in the sense that his expectations are fully realized. He is competing with another tenting "culture" benefiting from modern lightweight and high quality equipment and appearing to be more "urban oriented", thereby expressing a preference for more developed back country campgrounds, enjoying a certain degree of sociability and generally regarding the back country trip as a pleasant but short-lived relief from urban grind. There is little hard data to support these observations, but Stankey (Reference 57) and Lucas (Reference 44) have both observed that growth in wilderness demand has primarily come from a group or groups who spend a relatively short time in the back country (one to two nights), who hike relatively short distances and

who prefer established campgrounds to camping in the "wild". (This observation has been supported by Ian Leaman, Regional Parks Officer in the British Columbia Parks Branch, Department of Recreation and Conservation. Leaman estimates that 90 percent of 'back country users' seek the standard campground facilities provided despite the vast tracts of wild country that lie immediatley adjacent to such areas.)

While there may be two or more tenting cultures, the group referred to above as a whole differs noticeably from the RV camping culture in terms of motivations, expectations and camping behaviour. Clark and his associates (Reference 16) found that campers in large wayside campgrounds sought high quality conveniences, entertainment and companionship, and showed a great tolerance of crowding, noise, litter and even vandalism, while still feeling that they were enjoying a "wilderness" experience. Clark et al called this group the "urban camping culture" for in many respects they are transferring an urban or suburban living pattern to a quasinatural area. The question soon becomes obvious. Should public agencies be the major provider, or in any way a provider, of campgrounds for these types of camping enthusiasts?

Shafer (see Reference 56) points out that campers are quite selective in their preferences, deliberately seeking certain kinds of campgrounds to suit their needs. La Page (see Reference 37) found that campers who chose private campgrounds were far more likely to enjoy meeting other campers than were campers visiting public campgrounds. La Page and Ragain (see Reference 41) investigated the changing camping behaviour of a mixed panel of 565 campers and found that a significant number of the "hardy" class of camper had cut back on their camping participation due to crowded facilities and the difficulties of finding camping environments satisfactorily suiting their preferences. In noting that the decay in camping participation by this group is offset by the increase in "first time" campers more tolerant of crowding and damaged natural environments, the authors warn that the "example" and "leadership" in "good camping behaviour" provided by this group may be declining to the detriment of the camping fraternity generally.

The supply of campgrounds is another factor that has influenced the growth in camping demand, yet has also reflected the differences in camping preferences among modern campers. The public sector has responded positively to the recent growth in camping demand and, as a result, provided many of the new campgrounds presently existing in North America. Part of the reason for this is a prevailing belief that outdoor recreation is a social good that should be provided as a public service at subsidized prices. This is a controversial policy, with a long history. It stems in part from a belief that outdoor recreation serves a vital function in maintaining a stable and healthy community, and in part that a subsidized service is the best way to ensure that low income groups are not unduly discriminated against. For discussion see Searles (Reference 55), Mack and Meyers

(Reference 45), Gans (Reference 25) and Bechter (Reference 5). Public campgrounds, particularly those found in National and Provincial/State parks, provide remarkably high quality and durable through somewhat standardized basic facilities at low prices. It is, therefore, not surprising that new public campsites cannot be built fast enough to meet the burgeoning demands. Public policy makers, therefore, must decide if it is their objective to continue to try and satisfy increases in campers' demands or to satisfy only on a selective basis camping demands that cannot be met by the private sector.

Public sector growth of campground development is exemplified by British Columbia. Since 1956, the British Columbia government has increased the number of campsites in its provincial park system from 711 to 4,674, yet the number of camper days per campsite is still growing (see Table 1). In fact, throughout most of the peak demand period (July and August) some 30 to 50 percent of the provincial park campgrounds are full, causing uncounted numbers of disappointed campers to search for other accommodation (see Reference 51). The picture in the Canadian National Park system is little different. Of 99 campgrounds for which firm data were available, 82 turned away campers at least once in July and August 1972, 47 were full on at least 10 days, 27 on at least 30 days, and eight on at least 60 days.

The results of all this is growing pressure on publicly provided campgrounds, which in effect means an increasing subsidy by the general taxpayer to the user. From camper fees, Canadian national park campgrounds generate only half the annual costs of maintenance and capital depreciation, according to evidence on file with Parks Canada. This means a subsidy of the order of $3 per camper night, or a total annual subsidy of some $3 million. British Columbia provincial park campgrounds are enjoyed by campers who pay only $2 -- one-third of the annual cost of construction, depreciation and maintenance -- a subsidy of some $4 per camper night, or a total annual subsidy of some $5 million. The situation would not appear to be too different in other provinces of Canada offering campgrounds in provincial parks or similar areas. The policy has traditionally been to provide campgrounds for all types of park visitors and to subsidize their operation and maintenance costs as well as their capital depreciation. With increases in camping participation, the types of campers and the number of camper days per person it would appear that public policy makers should reassess this situation, especially in light of an increased capability of the private sector to do part of the job.

The Private Campground Industry

La Page (see Reference 40), Burch (see Reference 8) and Bevins (see Reference 6) have made some interesting observations about the evolution of the private campground industry. Bevins likens the pattern to the growth of the

TABLE 1

CAMPING UNIT ATTENDANCE AND THE PROVISION OF CAMPING UNITS IN BRITISH COLUMBIA PROVINCIAL PARKS
1955-1970

	Camping Nights (in thousands)	Number of Camping Units	Number of Camping Nights per Campsite	
1955	160	711	225	(56.25)*
1956	200	1048	190	(47.50)
1957	250	1404	178	(44.50)
1958	400	1818	220	(55.00)
1959	550	2255	244	(61.00)
1960	650	2797	232	(58.00)
1961	760	3205	237	(59.25)
1962	840	3664	229	(57.25)
1963	910	3688	246	(61.50)
1964	850	3695	230	(57.50)
1965	1100	3733	294	(73.50)
1966	1170	3768	310	(77.50)
1967	1350	3802	355	(88.75)
1968	1280	4290	298	(74.50)
1969	1390	4625	300	(75.00)
1970	1580	4674	338	(84.50)

* This figure represents the average number of people using a camping unit for the appropriate year. Actual nightly use of campsites can be estimated by dividing four. This figure is provided in parantheses.

Source: Parks Branch, British Columbia Department of Recreation and Conservation; Annual Reports.

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grocery store, from the small come-by-chance operation through successive stages of centralization and product specialization to the large supermarket. In essence, the evolution of the private campground is sketched as follows:

(1) Scattering (1900-1950). A disparate scattering of small commercial facilities, primarily catering to a well-established clientele, e.g., hunting and fishing groups.

(2) Invasion (1950-1965). The growth of the family camping market encourages small come-by-chance

campgrounds, generally family-run or on family-owned land, not always well situated in relation to tourist travel patterns. Some do well by virtue of location, good management or sensible investment, but many remain small peripheral operations that fail to break even, even if labour is priced at its opportunity cost.

(3) Concentration (1965-197?). The rise of the large, high investment campground, efficiently run and well promoted. These are often franchised to camping chains, (e.g., Kampgrounds of America, Crazy Horse Campgrounds, Safari CAmpgrounds, etc.), they are managed as sound business propositions and are expected to make money. They cater especially to the urban camping culture mentioned earlier, and expect to make as much money from day use facilities as from nightly rental fees, if not more. (Bevins estimates that these campgrounds can expect to return at least 8 percent on investment over 20 years, even with moderate management. KOA operators expect to take $8 per camping family per over and above rental fees, usually $4.)

La Page et al. (See Reference 42) found that the number of commercial operations in New Hampshire grew at an average annual rate of 8.3 percent over the seven year period 1964-1971, though there has been a more recent downward trend in the construction of new campgrounds. Moeller (see Reference 49) pointed out that for New England generally, the ratio of public to private campgrounds shifted from two to one in favour of public campgrounds in 1961, to four to one in favour of commercial enterprises in 1967. In British Columbia, Anderson (see Reference 2) found that private campgrounds outnumbered public facilities by a factor of four, and that 160 of 210 private operators interviewed planned to expand their facilities in the foreseeable future. A similar indication of optimism was reported in the previously cited U.S. studies.

On the surface at least, the private campgrounds in North America present a paradox for they generally do not pay, yet they are numerous and proliferating. All studies point to the marginal nature of the majority of existing private operations. Johnson (see Reference 32) remarked that at least three of five private campgrounds fail within five years, while half of the remainder do not break even. La Page et al. found that 89 of 167 reporting campgrounds in New Hampshire were unsuccessful in the sense that either income and/or occupancy was below average and revenue was insufficient to meet average costs. They comment (page 10 of Reference 42).

A simple comparison of costs and returns revealed that the average campground will not break even unless: (1) the owner can avoid paying for labour and ignore depreciation, which is probably what a great many campground owners have done in order to stay in business; or (2) the campsite rental income can be supplemented by additional revenues that will net at least 19 cents for every dollar of campsite rentals.

In Anderson's study, 50 percent of the 217 reporting managers claimed they made some profit, 25 percent said they broke even, and 25 percent admitted to taking a loss. However, the costs of labour and general maintenance were not incorporated in their budgetary breakdown.

The successful campground should be large enough to attract a sufficient "critical mass" of campers to make these critical on-site, noncamping facilities pay. To meet the narrow criterion of profitability, (defined initially even more narrowly in terms of attendance) most writers agree that the minimum number of units is 70, though profitability correlates positively with size through a very wide range above this number. For example, in a survey of New Brunswick private campgrounds (see Reference 50) it was found that the average occupancy rate for campgrounds of less than 10 units was 13 percent, while for campgrounds of over 100 units, it was 41 percent.

Most of the studies available show that at least half of the private operations are successful, within the parameters of success established by the managers themselves. Success is a subjective phenomenon, which is clearly linked to management goals and motivations. There has been an implicit assumption that the private campground enterprise should meet all the requirements of a profitable business to be successful -- promotion of product, differentiation of service, efficiency of management and maximization of new revenue through optimal fee structures. Yet a number of writers (for example Loomis and Wilkins, Reference 43, and Bevins, Reference 6, have hinted that other motivations, not based on money or profit, might apply. This matter is of fundamental importance in assessing the function of the private campground sector in modern times, for a purely economic calculation simply cannot be applied in assessing the viability and intrinsic merit of this sector. Therefore, in developing policy for the private campground sector these types of factors should be considered.

What motivates the private campground owner/manager? The ordering of the list that follows is not of particular significance, as any combination of factors can be expected in individual cases.

(1) Personal considerations. This group of factors includes the wish to remain active in retirement, despite a comfortable income, the

love of meeting people, the satisfaction of providing a service that is appreciated and the contentment that comes from setting up and operating a family business. These are psychic benefits, which may act as very powerful drives to certain individuals who still seek a sense of fulfillment in their lives.

(2) Family considerations. The private campground is often regarded as a family enterprise to provide employment for the wife, children and relatives. The short season and variable weekly occupancy rates, plus the somewhat "menial" chores involved are most appropriate for family labour with a stake in the total investment.

(3) Joint business operation. In all but a few instances, the private campground is a secondary source of income. In many cases, the primary occupation is a related business (a motel, riding stable, restaurant, etc.), but increasingly the campground may simply provide a relief from a city job.

(4) Investment security. In a period of sharply rising land values and steady erosion of the earning power of the dollar, the private campground is regarded as a sound investment, even though it may lose money on a year basis. Land values are rising at between 7 and 10 percent annually -- even higher in areas that are recreatively attractive (lakeshores, hillsides, etc.) or beside areas of great recreation interest. Operating a private campground on choice land can often be a convenient method of offsetting taxation and may provide a useful holding operation before selling out to some profitable use.

According to La Page's hypothesis, the successful campground is characterized by a high proportion of repeat campers, a lengthy duration of stay and widespread word of mouth "advertising" to attract new campers. The three interact, for the satisfied camper is more likely to return, to stay longer and to tell his friends and acquaintances about the campground.

While all these things are important, the human element is vital. The campground owner should be willing to work hard, to enjoy open socialization, and have a friendly, open personality. Courteous, friendly and responsible management not only maintains a clean attractive site, but encourages campers to return and to recommend the place to their friends. La Page (Reference 36) and Echelberger and Shafer (Reference 23) found that managers who were experienced

campers tended to antagonize their clients by providing a service which they thought was appropriate, but to which many campers objected. Clark et al. (Reference 16) pointed out that there is a disturbing difference of opinion between what many campground managers regard as a suitable atmosphere and the kind of experience many modern recreationists are seeking.

Though profit maximization may not be a primary motive, the private campground manager is nevertheless interested in attracting a large and regular camping clientele. In order to be successful in this regard, he must understand and seek to meet the preferences of the particular camping culture he wishes to attract. La Page (Reference 40) has developed a useful schema of camper preferences and management behaviour on which Figure 1 is based.

What are the features of the private campground that satisfy the camper in the first place? Certainly a neat, clean campground, with high quality sanitary facilities is a primary requisite. The CORD Motivation Study (see Volume III) showed that the quality of sanitary facilities, good drinking water and a clean campground are regarded by most Canadians as essential factors for making a good camping trip. The growing use of the RV has placed much importance on the "hook-up" campsite -- water and electricity certainly, and in many cases sewage disposal as well. Many campers simply expect this level of service now -- and generally appear to be willing to pay for it. Security against petty vandalism and unruly behaviour is also a very important factor. Indeed many campers deliberately choose private campgrounds to be sure of a peaceful night's rest. In both cases the private sector can provide a better service than most, if not all, public campgrounds.

Also very important is the provision of some form of "day-time entertainment". Successful private campgrounds provide a mix of services to meet campers' preferences on a 24-hour basis: the idea of overnight accommodation and little else is only successful for transit campgrounds located adjacent to major travel routes. Daytime facilities include swimming pools, rental facilities, grocery and gift stores, entertainment shows and the like.

Preferably, too, the campground should be near a major scenic or tourist attraction, such as a park, an historic site or an urban centre. The presence of water-oriented recreation facilities seems to be particularly appealing.

Attractive recreation sites seem to attract campgrounds, and hence it is not unusual to find a marked clustering of campgrounds around areas of recreation interest. Anderson (Reference 2) found that 61 percent of his interviewed sample of 208 managers were less than 10 miles from a public campground, and 74 percent were within five miles of private competitors. (Moeller, Reference 49, has similar evidence of clustering for New England campgrounds.) Clustering is advantageous in that it provides flexibility of choice for the camper, allows for the absorption of overspill and permits the positive

Figure 1

Camper Preference

past visits, camping experience, trip plans, preference for campground attributes (size, facilities, sanitation, age, location, accommodation arrangements, etc.)

Increasing Visit Length

slower turnover rate
guaranteed customers (reservations ahead)
good references (word of mouth)
lower labour costs
ancillary income from additional expenditures

Greater Likelihood of Return

good management-customer relations (improvement of facilities)
guaranteed customers
lower advertising costs

Simple diagram showing relationship between campground attributes, customer preferences and management to make a private campground viable.

(after LaPage, 1967, 1968a)

externalities of advertising and promotion.

SUMMARY

There is no doubt that the private campground can provide a set of services that are attractive to a segment of the modern camping culture. How many campers actually prefer private campgrounds to the exclusion of public campgrounds (and vice versa) is not known, but there is some evidence that a sizeable proportion of modern campers is ready to go to either. Both The CORD Motivation Study and a more recent study by La Page and Ragain (see Reference 41) showed that between 20 and 40 percent of touring campers can be termed "impulse campers", willing to shift their travel schedule at a moment's notice. Obviously, this group provides a prominent target for the sharp entrepreneur, eager to encourage them to stay for the extra day or so, and to return in the future. It would appear, therefore, that public agencies should seriously consider a policy of divesting themselves of part of the responsibility of providing "all things for all people" when it comes to campground facilities.

Public campgrounds in national and provincial/state parks tend to provide a relatively standarized quality service that is subsidized by the taxpayer. These campgrounds are becoming increasingly expensive to construct and operate, and are regularly over-crowded during the peak season. The private sector is prepared to offer a complementary service to absorb part of the demand, and to provide the kind of camping experience that a sizeable group of campers prefer. Should the public sector follow a policy of giving the private sector more of this responsibility, then it may follow that the public sector will, in the future, have additional funds to allocate to the provision of campgrounds of the type that the private sector cannot possibly provide.

SURVEY OF PRIVATE CAMPGROUNDS IN ATLANTIC CANADA

Four National Parks formed the foci for this study -- Prince Edward Island, Cape Breton Higlands, Kejimkujik and Fundy (see Figure 2). Table 2 portrays the public-private campground mix in and around these parks and also indicates the popularity of the public campgrounds.

The author (O'Riordan) contacted and interviewed the operators of 40 private campgrounds in the recreation hinterlands of these National Parks -- eight in the vicinity of Fundy, five near Kejimkujik, seven around Cape Breton Highlands and 20 in Prince Edward Island. The interviews followed a semi-structured format. Certain key questions were asked of all respondents, but there was plenty of

TABLE 2

THE PUBLIC-PRIVATE CAMPGROUND MIX
SURROUNDING ATLANTIC CANADA NATIONAL PARKS IN 1972

	Number of Park Campsites	Number of Private Campsites in vicinity*	Number of Nights Park Campgrounds Full or Nearly Full in 1972
Prince Edward Island (PEI)	613 (3)**	1600 (24)**	50
Cape Breton Highlands (Nova Scotia)	933 (7)	533 (7)	10-30***
Kejimkujik (Nova Scotia)	330 (1)	300 (5)	30
Fundy (New Brunswick)	960 (3)	784 (8)	30

* defined as within a radius of 40 miles

** number of campgrounds

*** varies from one campground to another

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flexibility built into the interview schedule to permit a reasonably deep insight as to the nature of the private campground industry in Atlantic Canada. Each interview lasted for at least an hour, and many exceeded two hours.

Analysis Strategy

Analysis of the interview results showed that four categories of campground could be distinguished on the basis of scale, level of service provided, management motivation, income generation and profitability. These are:

(a) the small scale, well established campground (60 units, 5 years in operation);

(b) the small scale, recently established campground, (60 units, 5 years in operation);

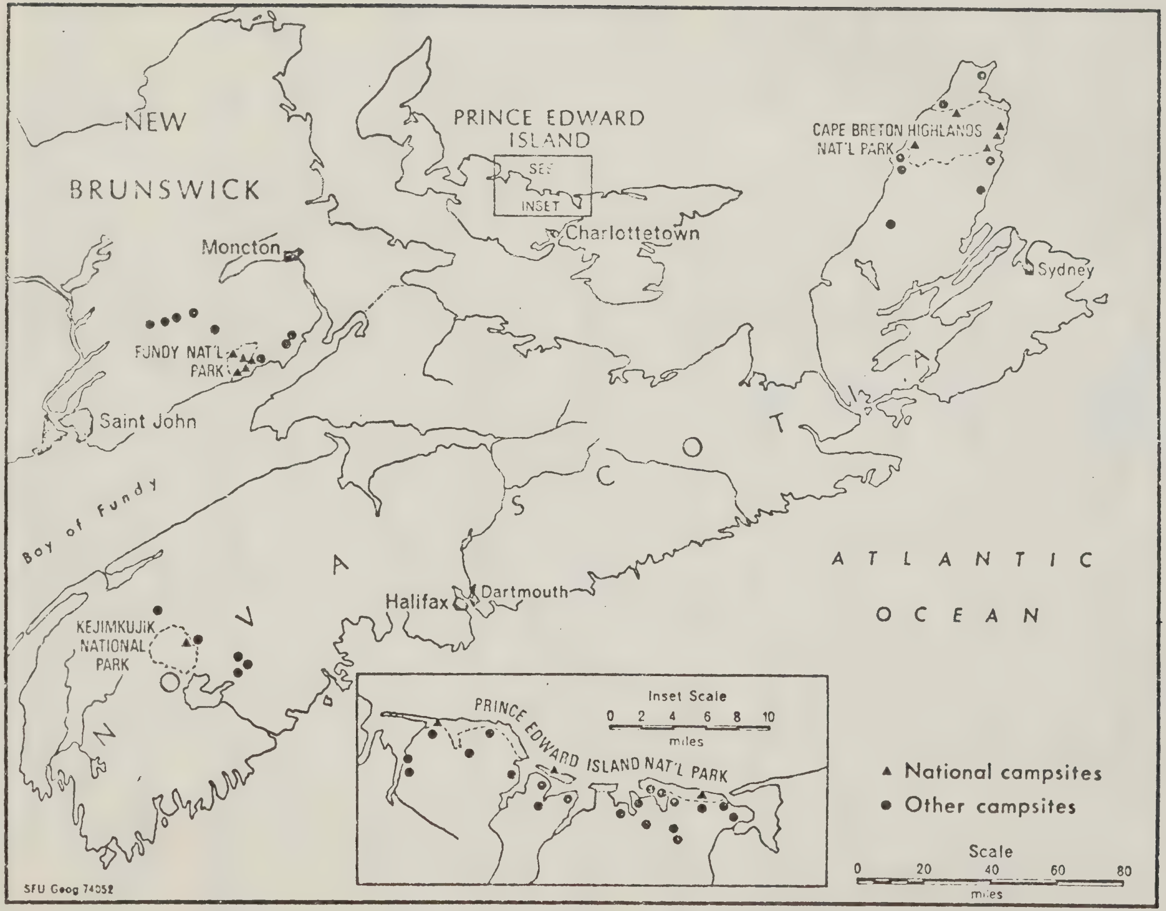

Figure 2 Location of Atlantic Canadian National Parks, National Park campgrounds and private campgrounds investigated in this study.

(c) the middle scale, well established campground (60 - 150 units, 5 years in operation);

(d) the large scale, recently established campground (150 units, 5 years in operation).

Results

It should be noted that there is no dearth of private campsites in the hinterlands of the parks surveyed, yet in three of the four areas, public campsites outnumbered private campsites (see Table 2).

While income generation was obviously an important consideration, few were in the campground business to make money. The viability of the industry should be evaluated as much on its merits for providing a local, friendly service to travellers as on the more rigid yardstick of dollar profitability. Before analyzing the industry in detail, first some general observations.

The Atlantic Provinces are not geographically well suited for large numbers of tourists. Their own populations are relatively small, they form a destination region rather than a travel routeway, and they suffer from a comparatively short summer season. Geographic isolation does mean that once travellers decide to visit the region they tend to stay a while. The unpredictable summer weather encourages the travel-minded to tour around, making it difficult for campground operators to capture the prolonged attendance which is so desirable.

Probably the biggest problem facing the campground manager is the short season. The peaking of camper demand for the private sector is quite dramatic: with some exceptions, most campgrounds report less than 10 percent occupancy up to June 30, 40 percent July 1 to 7, 90 to 100 percent July 8 to August 13, 40 percent August 14 to 28 and 10 percent August 28 to Labor Day. Comparative occupancy rates for National Park campgrounds for two selected months in 1972 are detailed in Table 3. General exceptions to the rule are campgrounds situated beside well travelled roads or in secluded water-oriented recreation areas which pick up early and late season local trade.

The sharp peaking of camper demand means that campground operators have to provide high quality expensive facilities (to meet the discriminating tastes of modern campers) for a season that effectively lasts for only five weeks. Of particular concern is the marginal cost-benefit calculation for additional facilities such as flush toilets and showers, which may only be used during the last two weeks of July. With current costs (even excluding labor which is usual internalized) and high interest rates, these expensive marginal investments could take 15 or more years to be paid off. (For example, modern sanitary facilities (toilets and showers) with proper sewage disposal can cost

TABLE 3

OCCUPANCY IN MARITIME NATIONAL PARK CAMPGROUNDS
JUNE AND SEPTEMBER, 1972

CAMPGROUND	Number of Sites	Number of Party Nights/Day June	Number of Party Nights/Day September	% Occupancy June	% Occupancy Sept.
CAPE BRETON					
Ingonish	108	6	6	5	5
Broad Cove	218	36	33	12	11
Black Brook	187	3	6	1	2
MacIntosh Brook	30	37	33	10	10
Cheticamp	250	36	25	13	10
P.E.I.					
Stanhope	170	54	34	30	20
Rustico Island	148	14	60	10	40
Cavendish	320	147	64	42	22
FUNDY					
Chignecto	525	12	8	2	1
Tenting Headquarters	125	76	46	65	37
Trailer Headquarters	29	24	23	80	75
Point Wolfe	250	31	7	11	3
Wolfe Lake	60	7	--	11	--
KEJIMKUJIK					
Jeremy Bay	330	39	47	11	13

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between \$20,000 and \$30,000: at 10 percent, this would mean annual payments of \$2,350 - \$3,425 over 20 years.)

Another factor contributing to the short, sharp nature of the private campground season is the competition provided by the public parks. In PEI for instance, few residents of the province appear to camp in private campgrounds: usually the beach is within a day's drive of home, or people tend to camp in public parks. In 1972, some 55 percent of all provincial park campground users were Islanders, and while only 8 percent of the PEI national park campground users came from PEI, some 50 percent of all users in June and September were local people. In Nova Scotia and New Brunswick, a similar pattern has been observed by local officials, though hard data is less easy to come by. But the practice of leaving a trailer in a secluded private campground for weekend use throughout the summer is growing in popularity, and provides a steady and guaranteed income

for the private operator, though often the rates are remarkably low. (Season rentals ranged from $100 to $200 or about $1 - $2 per day for a fully serviced site. Daily rentals for similar sites range from $3.50 to $5.00.)

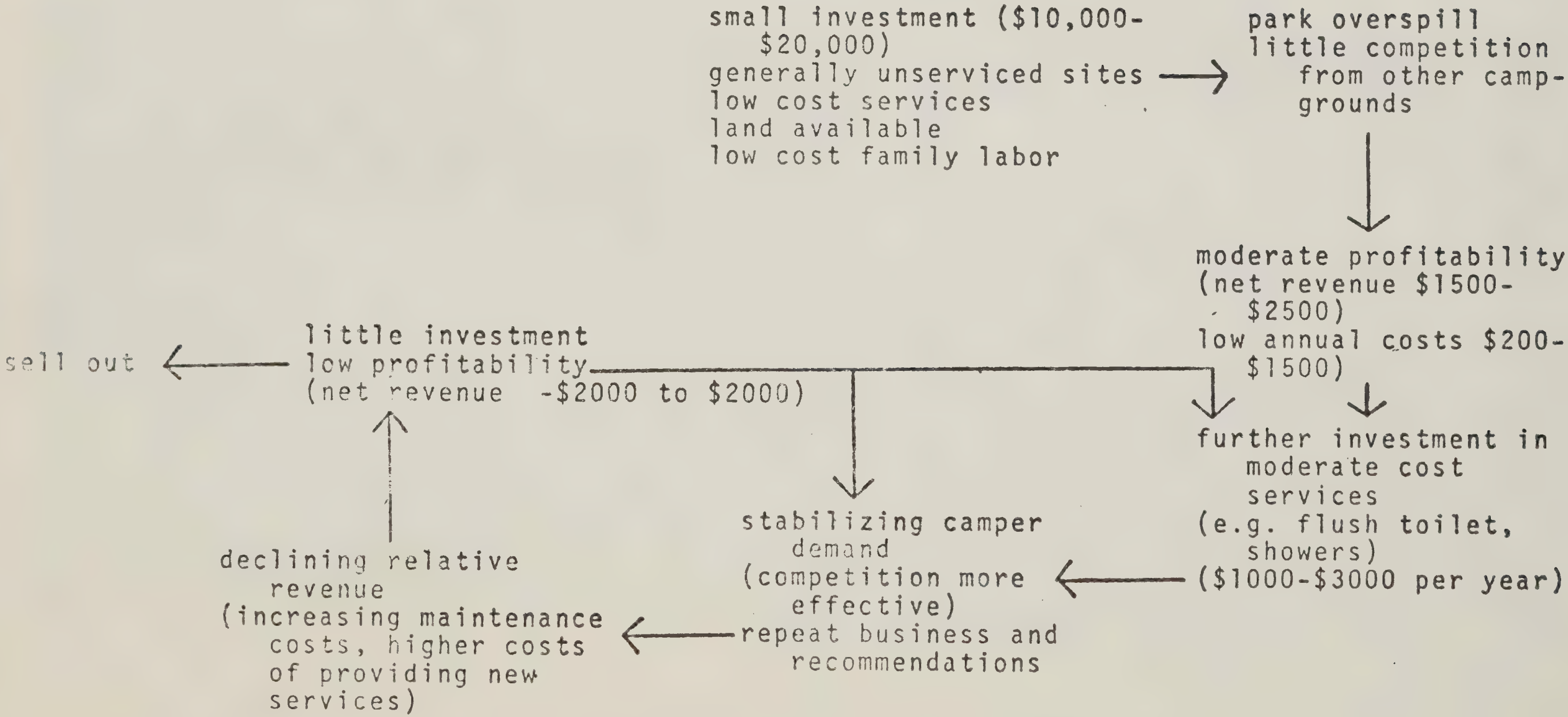
The four classes of campgrounds (as outlined in the analysis strategy) are described as follows:

(a) The small-scale, well established campground. Five campgrounds fell into this class, and none made any money. Despite small capital investment ($20,000) and very low operation and maintenance costs ($800 - $1,5000), plus very hardworking family labor, camper revenue rarely exceeds $2,500 annually. The moderate revenues reflect low attendance figures (rarely exceeding 20 percent for the season), and low fees ($1.50 to $2.50 per unit per night). Any net income is automatically ploughed back into the business for small scale improvements, but in 3 of the 5 cases, the owners were paying $1,000 - $2,000 annually out of their own pockets to keep their operations going. The owners are basically trapped by the peculiar economics of the private campground industry, (see Figure 3).

Because their campgrounds are relatively old, the basic facilities are somewhat primitive in the view of many modern campers, and often in need of repair. Competition has forced most of this group out of business. Those that hang on exist largely because they enjoy meeting and serving campers, and are committed to the operation as an investment. Because none of the owners is financially well-off, it is difficult for them to break out of a financial bind to upgrade existing facilities and, in any case, their campgrounds are not regarded as a sufficiently important source of income to warrant such a move. So the owners rely on repeat business (the length of time in operation is crucial here) and word-of-mouth advertising, can depend upon attracting some people off the road who are unable to find accommodation in nearby public facilities. Depending upon their location in relation to recreation areas and/or main highways, repeat business ranges from 10 percent to 80 percent, multi-night campers range from 5 percent to 60 percent, and word-of-mouth referral ranges from 20 percent to 80 percent. Even without some form of low-interest loan program, and assistance in advertising and technical services, some of these campgrounds will probably tick along at the margin for a number

Figure 3

The Small Scale Campground in Operation for 5 Seasons or More



of years to come.

(b) The small-scale, newly established campground. As mentioned earlier in the general review (but contrary to the evolutionary process described above) this category of private campground is growing. Fifteen of the 41 campgrounds studied fell into this class. This group is caught in another kind of trap (see Figure 4). Because these campgrounds are new, they have no established camping clientele and must compete in a tough market to attract the modern camper. This means expensive high quality facilities, including 2- and 3-way hookups, good showers and toilets, sewage disposal and a grocery store. Investment costs easily run to $50,000, and operating costs are also high (6,000 - $12,000 annually) due to high interest payments, rapid depreciation, insurance and utility bills, advertising costs and, in some cases, part-time labor.

During the initial years, camping revenue is pitifully small - $500 - $2,500 annually. About 90 percent of campers spend less than two nights, particularly if the weather is poor, so the difficulties of enticing them to stay longer are most challenging. Low camper demand is not simply due to newness, but often to poor location: 5 of the 15 campgrounds in this group were located off main highways, and another 8 had no recreationly attractive additional campground features to encourage campers to linger. The long-term prospects of this group will depend upon location, management and quality and variety of on-site services. Any form of low-cost advertising is tremendously important, as would be low-interest loans and technical assistance, to assist expansion. But it should be emphasized that this category of campground will always be financilly marginal, unless its capital investment is expanded and it develops a more aggressive marketing policy. But the question arises - is there enough camper demand to justify this increase in supply? This issue will be discussed in the last section of this paper.

(c) The middle-scale, well established campground. This group is well established (9 of 13 had been operating for five seasons or more) is generally well located and has invested in some on-site facilities to encourage multi-night visits. This group is solvent, well

located vis-a-vis recreation attractions (including the nearby national park), and benefits from a satisfied camping patronage, as outlined in Figure 1. Whereas 16 of the 20 small-scale campgrounds reported that 40% - 90% of visitors stayed only one night, and few remained more than two nights, the majority of campers visiting the middle-scale group stayed for a week or even two weeks. Capital costs range from $40,000 to $100,000, depending upon the number of campsites and the capital intensiveness of income generating activities (see Figure 5). Operating costs are also high - largely because of additional labor - running from $3,000 - $8,000 annually. The revenue picture is bright - ranging between $5,000 to $15,000 from camper fees and $1,000 to $15,000 from additional facilities. Net revenues ranged from around $2,000 to $10,000 or more, depending upon whether the ancillary business was campground related or not. In no case are big incomes being made, but these owners can face competition and provide a very acceptable service. In many cases, the building up of the campground to improve its investment potential for the capturing of added value (whether by hard work or by speculative pressures) is a major economic motivation.

(d) The large-scale campground. This group is distinguised by size (exceeding 150 units), scale of investment (exceeding $100,000) and the fact that some of the management is professional. The aim is to make money, particularly through day use facilities (restaurants, gift shops, pin ball machines, rental facilities, etc.). Unfortunately, all but one of the seven campgrounds falling into this class were in operation for less than two seasons, so it is impossible to predict their viability. Investment costs are enormous (ranging up to one million dollars) and operating costs are likewise high ($20,000 to $50,000) -- the labor costs alone may exceed $25,000. Indeed, one of the large-scale campgrounds spent more on cash registers alond ($25,000) than a well established small-scale campground owner will invest in his lifetime. This group relies on expensive publicity (advertising costs range from $1,000 to $4,000), on the very best quality sites, and on expensively planned space. Two- and three-way hookup sites are almost mandatory, costing $600 to $2,000 each to install (as against

$200 to $1,000 for similar sites in smaller campgrounds, where most of the operators do their own plumbing and wiring -- even if land costs $500 to $1,000 an acre.

Of critical significance to the large-scale campground is the fact that the future profits will be determined (though to an uncertain extent) by national park campground policy. Initially, the private operators' aim is to absorb and hold as much of the national park overspill as possible. Their more distant objective is to see the national parks abandon the campground business altogether. It soon becomes apparent, therefore, that if national park campground policy is unclear or continually changing, then even operators fitting the category of large-scale campgrounds will find it difficult to make wise decisions and long-term commitments to their enterprise.

Figure 4

The Small Scale Campground in Operation Less than 5 Seasons

high investment ($40,000-
$70,000)
serviced sites
high cost facilities
land generally available
low cost family labor

→

marginal location
little park overspill
heavy competition
little known

↓

low initial returns (gross
income $500-$2500)
high annual costs
($6000-$12,000)

↓

dependent upon
- increasing tourist
demand
- clean facilities
- family management
- growing reputation

←

slowly increasing camper
demand
(gross revenue $4000-
$10,000)

←

increasing annual costs
problem of expensive
investment in little
used marginal
facilities

↑

continued low profitability
(net revenue -$1000 to $4000)

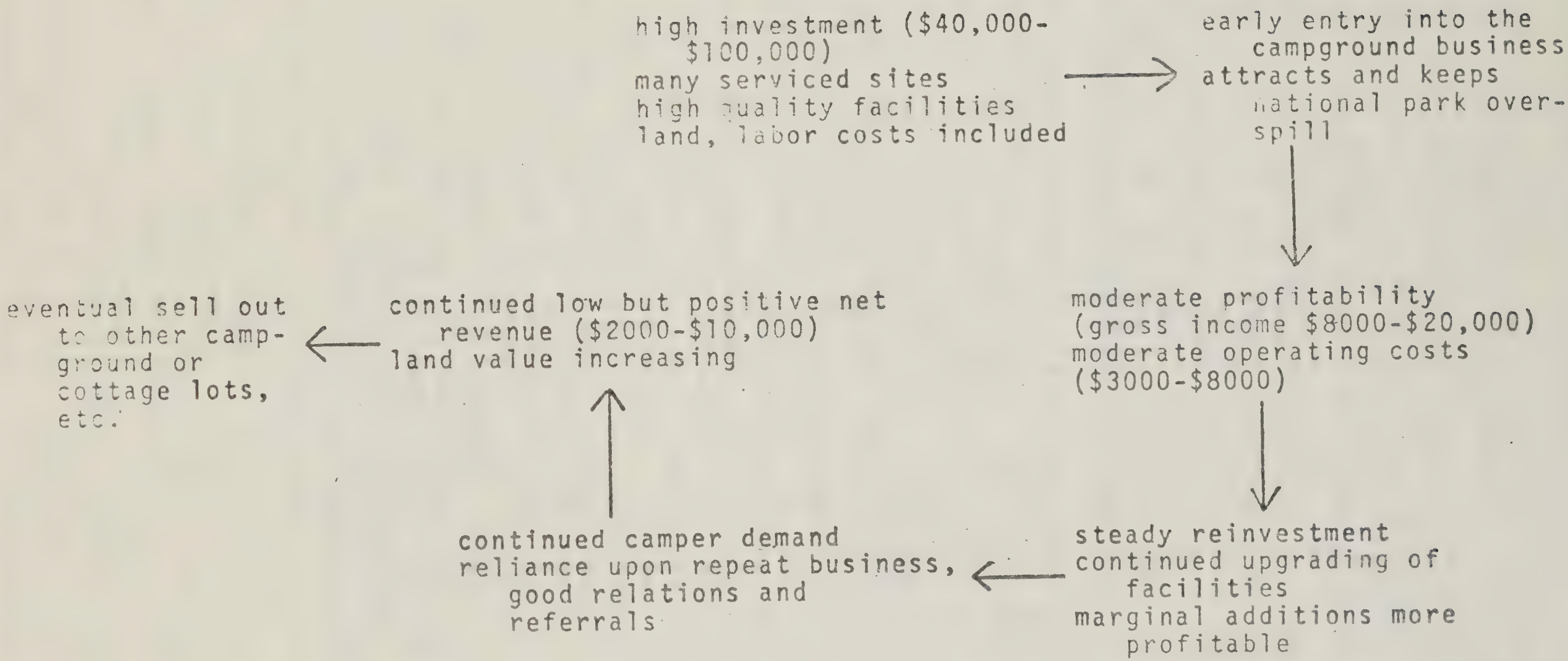
→ slowly increasing camper demand

←

sell out

Figure 5

The Middle Scale Campground with Additional On-Site Facilities



A national park, in many cases, forms a focus for a tourist or recreation hinterland which, in certain instances, can provide a variety of recreation experiences of a natural, social and cultural character. The park offers a distinctive natural setting in which camping should be a complementary activity, impinging only lightly on the intrinsic natural values of the park. Simple functionalism should be the policy -- basic facilities, no frills, but the opportunity for different camping cultures to seek a satisfying experience within a limited range of campground options provided by the park.

It would appear that national park campgrounds should offer a complementary service to the private sector. Where unnecessary competition exists, it should be eliminated, as may be the case with national parks providing fully serviced campsites.

A second area of unnecessary competition may exist in the area of early and late season camping. National park policy allows for campgrounds to be made available to park visitors early and late during the season at no charge, since it is not economically viable to collect fees. The policy rationale in this case is that the parks and campgrounds are paid for by all Canadians, so they should be made available if at all possible. However, this policy makes it impossible for adjacent private campgrounds to compete during the off season. Obviously, the policy requires some re-evaluation.

Comparative fee structures should also be analyzed. In some cases, the national park campgrounds charge more for serviced sites and less for unserviced sites than does the private sector. Should national parks raise their fees for the latter kind of site, the private sector (especially at the smaller scale) would benefit enormously. Yet camper demand would hardly be altered, as price elasticity in this part of the fee structure is pretty low (see Reference 39, 51). The main point, however, is that it would appear that national park campground fee structure policy is developed with little regard for the private operator.

In the United States, some national parks have embarked on a reservation system, which guarantees a site to those who buy an advance "insurance" fee. Should Canadian national park campgrounds follow this practice? On the one hand, the reservation system can give campers greater assurance of a place and can permit parks officials to turn overspill campers to adjacent private campgrounds. On the other hand, a reservation system might stop campers from even visiting an area once they learn that the national park campgrounds are full. On balance, it would appear that a reservation policy should be discouraged, especially in areas where adjacent private campgrounds exist.

Since national parks, in many cases, serve as the focus of a tourist region, it might be suggested that they should be responsible, in part, for establishing (along with

provincial and local tourist interests) regional tourist information centres, providing information not simply on the park, but on nearby indoor and outdoor recreation attractions and local accommodation. While this would require a change in the existing national park information policy, it would offer the benefit of providing the camper with informed choices as to the variety of campground facilities available, as well as giving him alternatives when his first preferred campground is full. The notion of a national park-centred tourist region could give a much needed advertising boost to the smaller campgrounds, many of which would do quite well if they were better known.

It should be noted, however, that the above policy might not solve the private operator's initial financial difficulties. Here, a careful case-by-case analysis is necessary before any policy of low interest loans can be advocated. (With only two exceptions, campground owners surveyed did not desire a 'handout' grant: they were happy to work to pay off a loan. However, the peculiar economics of the industry might well necessitate subsidized loans -- say at 6 percent -- for certain basic facilities.) The question of standards and technical assistance can partly be dealt with through existing minimum standards set by provincial agencies. But the sharing of technical know-how could be made possible through provincial campground owners' associations, such as is done in New Brunswick. (A fine example of this practice is the work being done by the New Brunswick Campground Owners' Association.) In conjunction with this is the related alternative of changing the existing national parks policy so as to enable technical expertise from the Parks Canada to be made available to the private sector.

Finally, the national park-centred tourist region carries with it the more subtle issue of protecting local cultural values. The well established small campground entrepreneur, who may appear economically marginal, is an intrinsic part of the local scene. He knows the folklore, he knows local customs and he is in regular contact with local people who can offer a marvellous service to the camper anxious to identify with the local scene. The private campground industry is a part of a local culture, which is complementary to the natural scenery of the national parks. To link the two would help forge a regional, participatory visitor service, which could be enjoyed by local residents and non-residents alike.

L. Douglas

The papers presented in this chapter represent a paradox. In a technical sense they are rather simple, at least in comparison to some of the technical notes found in other chapters.. On the other hand, some are highly innovative and provide significant additions to poorly developed area of park and recreation research.

In the past, evaluation and allocation modelling has played only a minor role in Canadian park and recreation decision making. Senior administrators have often stated that much of the analysis that has taken place has been too narrow in focus and not orientated to the type of decisions which managers have to make. These critics have challenged researchers to develop simple yet meaningful measures of level of service, frameworks for evaluating alternative sites and projects, and better methods for analyzing the economic impact of parks.

In a general sense TN 5, 17 and 26 provide the policy-maker with a number of ways of determining level of recreation service available to certain populations. Implicit in these models is the concept of equity of opportunity and an interest in isolating areas which are relatively well or poorly serviced. TN 5 and 7 develop measures of opportunity potentially available to different populations. These papers make no use of participation data. In contrast, TN 26 only uses participation data in developing internal standards for various areas and socio-economic groups.

TN 5 shows how the concept of potential surfaces may be used to develop measures for evaluating the distribution of opportunities to participate in outdoor recreation. Two approaches for specifying "opportunity quotients" are developed in the article. With the first alternative, it is proposed that competition for supply is best measured at the recreation site. However, a means of measuring total pressure exerted on a site is not proposed. With the second alternative a proposal is made that competition be measured at the residence of each individual. The concept of population potential is suggested as providing a surrogate measure of this competitiveness. The "opportunity quotient" developed in the second alternative is, in some respects, suggested to be superior to the one developed in the first alternative since it more accurately reflects how a person perceives his relative opportunity. However, neither the question of which distance function to use with a specific gravity function, nor the question of how to obtain the best gravity function is answered in the article. The matter of how to measure site attractivity is also left unattended.

A number of matters need to be considered before it can be accepted that either of the proposed measure reflect the

recreation opportunities perceived by people living at specific locations. For example. "opportunity quotients", as defined by the two alternative methods, should be calculated for specific areas and then compared with the perceived opportunities as stated by people living in those areas. Other useful projects could investigate whether or not these measures relate to potentials as defined in the behavioural models postulated in TN 33.

TN 17 shows how policies such as those requiring that a certain per capita level of opportunity be potentially available within two hours travelling time of urban centres can be used to define a model which is appropriate for evaluating how recreation opportunities relate to populations. In this context, it is not of direct interest to know whether people use the opportunities allocated to them by the mathematical model. Rather, the concern is the number of opportunities potentially available to people living in various urban centres. Output from the model can then be used to evaluate the potential level of service presently provided to each urban centre in the study area against either a predetermined standard or an internal standard, such as the weighted average supply per capita for the study area. Once this evaluation is completed, expected population changes can be used as input to the model and, in the absence of additional supply, future ratios of supply per capita can be computed for all urban centres. Alternative plans for introducing new supply into the system then can be developed and evaluated through repeated runs of the model. Eventually, a plan can be selected which best relates to an agency's objective of providing a given level of service to the agency's expected fiscal resources within the planning period.

The allocation and evaluation approaches described in TN 5 and 7 do not make use of information on people's behaviour. In many cases, however, a decision maker may wish to take existing behaviour into account because it is believed that behaviour reflects level of opportunity. TN 26 offers a technique which can be applied to participation data in order to develop internal standards. It is stressed in the article that the analysis of such data should be done in a disaggregated way. For example, it is suggested that better policies can be developed by looking at participation rates of age-sex groups as opposed to only looking at a crude participation rate for an entire population. A careful distinction is made among various participation measures such as incidence of participation per capita, etc. It is pointed out in the paper that the selection of a participation measure (or measures) to be used in an analysis entirely depends upon the objective of the anlaysis and the range of actions likely to be taken as a result to the findings of the analysis. In this regard it is stated that participation rates based on income differentials may not be of any interest in a program evaluation analysis, whereas they may be critically important to the master planning of a particular park.

The remainder of notes in Chapter VIII relate, more or less, to evaluations and allocations based on economic considerations. The next two papers commented on consider the problems of project and site selection.

A multi-dimensional scaling system for project selection is developed in TN 25. In this scoring system, intangible variables are combined to produce a single subjective score for each project on a list of candidates. Next, a procedure is described by which the intangible score can be combined with the corresponding benefit-cost ratio of the project in a way that allows the decision maker to control the amount of influence that intangible factors have on the final project score.

The note includes some rather critical insights into the way intangible variables should be combined. For example, it is pointed out that the dimensions of evaluation should be independent and that the best alternative project on a dimension cannot be necessarily assigned a value of '100' while the poorest project is assigned a value of "0".

There is no recognition in the paper, however, that the weight each dimension should have in determining a project's value may vary from project to project. In the paper it is assumed that an average weight for each dimension can be applied to each project in the list. This assumption is only valid when essentially similar types of projects are being compared.

Still, this criticism of TN 25 is of minor importance given the more substantive problem of using intuition to specify scale values. In many cases, lack of time or money preclude thorough research being undertaken. Yet, a manager may still wish to subjectively include certain factors in the selection of a project. The scoring system described in TN 25 allows such intangibles to be included in a simple yet structured way. By keeping economic and non-economic factors separate throughout the analysis, it is possible to combine them in the final step in a controllable way. The procedure described, consequently, provides the manager with the opportunity of deciding how far he is willing to deviate from an economic optimum in order to achieve other objectives.

When an agency has used a model such as the ones described in TN 5 or TN 17 there still may be questions about making the optimal use of land. One approach to defining optimal use is to define an objective function and then to apply linear programming to determine whether certain lands would, for example, be best used for producing forest products, agricultural products, recreation products, or some combination of these. So when, for example, growth in a recreation system has been defined using the methods described in the discussion of TN 17, it might be considered feasible to develop a catalogue of potential lands for parks in areas which will face increasing pressure. Then, at any time, linear programming incorporating contemporary budget and other price constraints can be applied to select which of the lands should be developed for park purposes.

The main point of TN 23, however, is that over-automation of planning can lead to poor decisions. The creation of a park rarely only has the objective of providing a certain number of picnick tables. One must be careful to realize that a linear programming solution which indicates that a park should be developed on a particular site does not recognize differences in the number of jobs associated with different land uses nor does it recognize that future changes may occur in the relative price of the products that may be produced on that land. Discussing the results of a sensitivity analysis of the linear programming solution then only serves to illustrate that there are many options which are not automatically pointed out or even realized when overly automated evaluations and allocation procedures are used.

The authors of TN 23 note that the opportunity cost approach used for specifying the price of the outdoor recreation product in the linear programming application only permits the assignment of a minimum price. Furthermore, the opportunity cost approach says nothing about the value of the recreation product as perceived by consumers because of the absence of a demand curve.

Related to the need to have an estimate of the value of a proposed park is the discussion about time bias found in TN 31. In this article it is pointed out that estimates of the demand function that are only based on travel distances may severely underestimate the value of certain parks. The authors suggest alternative ways of incorporating a factor to correct time bias into a demand function and then they proceed to compute the effect of these alternative corrections on the estimated value of a Park. Consequently, TN 31 provides the manager with an example of how widely the estimated value of a park may vary, depending on the assumptions used in developing the demand schedule. Given the sensitivity of the linear programming solution found in TN 23, the manager may desire to have several estimates of value computed for a proposed park so that he can choose the one that he believes is most appropriate.

TN 39 is really only a focused review of traditional economic impact of park literature. The perspective presented in this paper is complemented by TN 40 where a broader view is taken on how the assessment of impact relates to the park planning process. The note leaves much to be desired because the literature on impact evaluation is now extensive and has progressed significantly since 1969. Many of the very real problems in collecting data for assessment evaluation such as the distribution of benefits and costs are generally more subtle than recognized in this paper. Consequently, the paper should only be used as an introductory guide to impact assessment.

TN 40 presents a broad perspective of the factors influencing the development of a park rather than a discussion of the classical economic issues related to the impact of a park. It is stated in the article that many of the impact statements prepared at the park proposal stage

have not turned out to be accurate because the factors defined in the original situations have changed. Results of impact studies have frequently been invalidated because impact was not considered when the original development concept was altered during the acquisition negotiation process or during the master planning process. The main point of the article is that the assessment of impact can only really be carried out effectively when a close linkage is retained between the impact assessment and the acquisition-planning process. If impact assessment is considered important, it is not enough to study impact at one point in time. The entire planning process from concept development through master planning and construction must be audited. Consideration must be given to the various exogenous variables that influence development, and continuing feedback between the planners designing the park and those estimating its impact must be maintained.

TN 41 provides a general description of the relations among campground characteristics and corresponding economic viability. The analysis, by its very nature, presents aggregated information and is consequently of limited value in drawing specific conclusions. Still, such studies are useful since they provide general guidance to the planner or manager who wants to consider roles that private campgrounds might play in park development schemes.

Even at a general level, however, a discussion of campground economics should consider certain other factors. For example, a more detailed account of development and maintenance costs is required. It would also be useful to know the expected rates of return from the development of special attractions. Finally, the paper would be more complete if it included a discussion of how specific types of clientele can be attracted to a campground and if it presented the advantages and disadvantages of pursuing such a marketing policy.

The various technical notes found in Chapter VIII represent initial attempts at providing program planners and policy makers with technical aids to making decisions. As pointed out in this review, the most important consideration in applying these models and other techniques is that they should accurately reflect the policy on which they are supposedly based. Such techniques must, moreover, clearly describe the implications of adopting general policies or making decisions related to specific projects.

Several different types of perspectives may be taken when policies and plans are being developed for the future provision of recreation facilities. One perspective could emphasize the importance of existing patterns of behaviour and base future plans on policies either related to modifying these patterns or to encouraging them to continue. If this perspective is taken, accurate models of existing behaviour are prerequisites to effective policy analysis and development.

In contrast, another perspective could be taken in which a priori assumptions, based on policy, are made about

how facilities should relate to populations. A model based on these assumptions would be formulated and used to describe the existing situation. Finally, future plans that result in a normative distribution of facilities in relation to expected future populations would be developed.

In many cases it can be argued that a policy or plan should never be developed from only one perspective. Such a view, however, should not be taken as an excuse for using a model ill-suited to the objective of the particular analysis being undertaken. Policy making is often a very complex exercise and it is the duty of the researcher or analyst to present, accurately and unambiguously, the implications associated with adopting various policy perspectives.

Future Research

From a review of the nine Technical Notes found in Chapter VIII, one can suggest a number of lines of future research. In respect to TN 5 and TN 17, it would be useful to develop a means of propating supply according to the factors of quality and variety. TN 26 describes how an almost infinite list of internal standards can be computed. A paper could be written that would outline how to use the results of methods described in TN 12 and TN 10 to indicate which standards should be considered when making a particular allocation. The method proposed for scoring projects, described in TN 25, could be improved by the incorporation of the concept that a particular dimension may not be equally important to all projects on a list of the candidates.

Regarding TN 23, further research could centre on designing procedures to test the sensitivity of linear programming for the purpose of allocating land to different uses. It is doubtful, however, whether the linear programming approach will gain widespread acceptance from park planners until techniques for defining the value of a particular recreation experience are improved. Further empirical work incorporating the concepts developed in TN 31 offers some promise in this direction. Probably, the main question regarding impact assessment is the selection of the proper level of disaggregation in analysis to obtain an accurate picture of who benefits and who pays when a park is developed.

The real priorities for research on modelling and allocation must, however, be defined by those individuals working at the interface of policy making and research. It is only through continuous feedback between these people that concensus can be reached about what techniques need to be developed for specific types of analysis.

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CHAPTER IX

TREND ANALYSIS AND PROJECTION ANALYSIS

INTRODUCTION

The two Technical Notes in this chapter are obviously not the only Technical Notes that have to do with trends and projections. In fact the reader may have the distinct feeling that TN 22 is out of place in this volume as it is the only one that focuses on a straightforward interpretation of data. There is no attempt at generalization but only commentary on what certain survey results show. However, this TN is included because, after the 1972 National Survey of Canadian Participation in Outdoor Activities, it was recognized that there was no base information available on trends in participation in outdoor activities. Also it was recognized that a note like this one would implicitly show the problems that arise when definitions are changed from year to year and when samples are so small that results cannot be presented for certain geographic areas for which it is very natural in Canada to want to have information. Specifically, one will note the disclaimer that the results for provinces may be so inaccurate as to be meaningless. TN 22 thus shows what could be done to define trends in participation in outdoor activities in 1972 on the basis of the surveys carried out and the CORD Study analysis that had taken place to that point in time.

TN 13 stands in stark contrast in that it contains no analysis of data but rather contains proposals for what can be done, given the methodological development that has taken place in the Canadian Outdoor Recreation Demand Study. Between the time when TN 22 was prepared and the time that TN 13 was pulled together as a presentation to be made to a group of Ontario geographers, TN 12 had been completed, TN 6 and 20 were in draft form and the ideas implicit in TN 11 and 20 were in a preliminary form. Many ideas had crystalized and this made it easy not only to come up with an analysis procedure that should be followed but also to point out the problems in following it with existing data.

Thus in this section the reader is confronted with what may be considered a mundane analysis followed by a thought piece that he might think more appropriate for the theory chapter of this volume. Regardless, the choice was to include these two notes in this chapter. In particular TN 13 lays out a quantitative route to follow in carrying out medium run (5 to 15 years)

projections.

It is unfortunate that there was not a delphi or other less conventional projection exercise carried out that could be a third paper in this series. However, serious interest in more modern approaches to futures research only really began to play a role in the thinking of people involved in the CORD Study near the end of the study. Such work is now being carried out on outside the Canadian Outdoor Recreation Demand Study.

TRENDS IN PARTICIPATION IN OUTDOOR RECREATION ACTIVITIES

S. Rousseau

ABSTRACT

In this paper data from three national surveys (in 1967, 1969 and 1972) are compared to provide insight into changes in the patterns of participation in outdoor recreation activities in Canada.

After explaining the characteristics of each of the surveys, the trends of the five-year period (1967 - 1972) are analysed for eight outdoor recreation activities on which comparable data was available. Then changes in the incidence of participation between 1969 and 1972 are analysed for seventeen outdoor recreation activities. Finally, changes in the frequency of participation are also briefly analysed.

Nineteen tables are presented throughout the discussion to give insight into regional trends, trends by age groups, by sex and by socio-economic level.

It is concluded that in the general context of increasing participation in outdoor recreation activities in Canada there are activities and sections of Canadian society that show some decrease in participation, a fact requiring some explanation.

INTRODUCTION

The goal of this paper is to briefly comment on data that give insight into trends in patterns of Canadian participation in outdoor recreation activities. Data from three national surveys, called the National Surveys, are compared. They give information on participation in certain outdoor recreation activities in the year prior to the Fall of 1967, 1969 and 1972, respectively. The data permit one to gain insight into the likely trends in participation in outdoor recreation activities for Canada as a whole. Moreover, they permit one to recognize changes in participation associated with region, age group, gender, socio-economic level, as well as a number of other variables.

Unfortunately, one point must be made abundantly clear regarding the figures presented in this paper. All are based on very small samples (the unweighted universe for 1969 is, for example, only 3000). Thus much of the variation, particularly in figures that are reported for

smaller provinces, is statistical. One need only compare participation rates in activities in Saskatchewan and Manitoba for 1969 and 1972 to become suspicious of a number of the rates presented. In part this paper has been made available to get information out to people so that they can react to it. In defense of what has been done, one must ultimately ask whether decisions on issues requiring trend data are better made with some information than with none at all. But the reader is warned that, rather than deprive him of information, sometimes questionable figures have been provided.

THE DATA

A complete explanation of the data used for this paper appears in Chapter 3 of Volume III. Table 2 in Chapter 3 (Volume III) was an adaption of a Table which was prepared for this Note. The questions asked in the 1969 and 1972 surveys, in order to determine the incidence of participation in outdoor recreation activities, were identical. However, the activities examined were not. The question read as follows:

> "Now I'm going to read you a list of outdoor activities. As I read each one, would you tell me approximately how many times, if at all, you have done each within the past year - that is, since about this time last year."

Unfortunately, in the 1967 survey, the question was formulated in the following way:

> "Here is a list of things that some people tell us they like to do out-of-doors. Which of these things have you done during the past year with your leisure time out-of-doors?"

As can be seen, the question asked in 1969 and 1972 permits one to determine not only the incidence but also the frequency of participation in outdoor recreation activities, while the 1967 question permits one to determine only the incidence of participation. This information is sufficient, however, to draw trends on the incidence of participation but one must be cautious concerning the comparability of the 1967 results with the results of the two other surveys.

The 1967 survey yielded information on twenty two outdoor recreation activities, the 1968 survey on five activities, the 1969 survey on twenty six activities and the 1972 survey on eighteen. The 1968 survey data are not used in this analysis. Its incompatibility with that of the other three years can be readily seen in Table 2 (Chapter 3, Volume III) and it is this that caused the decision not to present 1968 results here. Actually, only eight activities were surveyed in an identical manner in 1967, 1969 and 1972,

although questions about seventeen activities are worded identically in the 1969 and 1972 surveys (see Table 1.)

TABLE 1

COMPARABLE ACTIVITIES
IN THE CORD NATIONAL PARTICIPATION SURVEYS
1967 - 1972

A. Eight Comparable Activites

Tent-Camping
Trailer-Camping
Hunting
Power Boating
Canoeing
Snow Skiing
Snowmobiling
Picnics and Cookouts

B. The Twenty-Two Comparable Activities

Tent-Camping
Trailer-Camping
Hunting
Power Boating
Canoeing
Sailing
Visit Historic Parks & Sites
Driving for Pleasure
Sightseeing from Private Vehicles
Snow Skiing
Snowmobiling
Picnicking
Walking & Hiking
Ice Skating
Horseback Riding
Bicycling

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These facts determined the choice of presenting two sections of discussion on trends; the first is concerned with the eight activities comparable in the three surveys, and the second on the seventeen activities comparable in the 1969 and 1972 surveys. The readers who may be interested in knowing more about the four National Surveys referred to here or other CORD Study Data may refer to Volume III. A number of reports that might be of interest are listed in

the Appendix discussed in the following section.

TRENDS FROM THE 1967, 1969 AND 1972 NATIONAL SURVEYS

A more detailed picture of the evolution of the incidence of participation in outdoor recreation activities in Canada is available in Appendix B of a special version of this paper, available from THE LEISURE STUDIES DATA BANK, Waterloo Research Institute, at the University of Waterloo.

As is indicated in Table 2, of the eight selected outdoor activities for which data are comparable in 1967, 1969 and 1972, there is only one activity, Hunting, for which there was a steady decline in incidence of participation from one survey to the next. For the other seven activities there was an increase in incidence of participation between the 1967 survey and the 1972 survey. It should be noted, however, that only three activities (Power Boating, Canoeing and Snowmobiling) showed a steady increase in incidence of participation from one survey to the next.

In Tables 3 to 10, regional and national trends are given for each of the eight outdoor recreation activities for which there are data in the 1967, 1969 and 1972 surveys.

In Table 3 the figures indicate that, in all except the Atlantic Provinces, the incidence of participation in Tent-camping was higher in 1972 than in 1967. In four provinces (Quebec, Manitoba, Saskatchewan and Alberta) the incidence of participation increased steadily from 1967 through 1969 to 1972.

The figures in Table 4 indicate that the incidence of participation in Trailer-camping was higher in 1972 than in 1967 in all provinces. The percentage of individuals 18 years and over who participated in Trailer-camping tripled in Manitoba and Alberta between 1967 and 1972. There was, however, a constant increase between each of the three surveys for only two provinces: Manitoba and Saskatchewan.

The figures in Table 5 indicate that the incidence of Hunting was greater in 1972 than in 1967 for two provinces only: Manitoba and Saskatchewan. For Ontario, the percentage of individuals 18 years and over who participated in Hunting declined steadily from 1967 through 1969 to 1972. For Canada as a whole, participation in Hunting declined slightly but steadily through the years, although this pattern of steady decline does not seem generalized to all provinces. Between 1969 and 1972 percentages of participants increased in two regions: the Atlantic Provinces and Manitoba.

TABLE 2

PERCENTAGE OF CANADIANS 18 YEARS AND OVER WHO DID PARTICIPATE IN 8 OUTDOOR RECREATION ACTIVITIES IN 1967, 1969 AND 1972

ACTIVITY	1967 %	1969 %	1972 %
Tent-camping	14	12	19
Trailer-camping	7	6	10
Hunting	14	13	11
Power boating	15	19	23
Canoeing	5	8	10
Snow Skiing	6	7	7
Snowmobiling	7	14	18
Picnics/cookouts away from home	42	54	54

TABLE 3

PERCENTAGE OF INDIVIDUALS 18 YEARS AND OVER WHO DID PARTICIPATE IN TENT-CAMPING IN 1967, 1969 AND 1972, BY REGION

	1967 %	1969 %	1972 %
Canada	14	12	19
Atlantic Provinces	15	11	13
Québec	11	13	18
Ontario	13	10	19
Manitoba	8	10	18
Saskatchewan	8	13	15
Alberta	16	17	25
British Columbia	21	14	24

TABLE 4

PERCENTAGE OF INDIVIDUALS 18 YEARS AND OVER WHO DID PARTICIPATE IN TRAILER-CAMPING IN 1967, 1969 AND 1972, BY REGION

	1967 %	1969 %	1972 %
Canada	7	6	10
Atlantic Provinces	8	4	9
Québec	5	5	8
Ontario	6	4	10
Manitoba	6	7	18
Saskatchewan	9	12	15
Alberta	8	6	25
British Columbia	10	7	11

TABLE 5

PERCENTAGE OF INDIVIDUALS 18 YEARS AND OVER WHO DID PARTICIPATE IN HUNTING IN 1967, 1969 AND 1972, BY REGION.

	1967 %	1969 %	1972 %
Canada	14	13	11
Atlantic Provinces	21	15	21
Québec	11	12	10
Ontario	12	10	8
Manitoba	8	11	12
Saskatchewan	12	19	16
Alberta	14	14	8
British Columbia	15	16	15

In contrast to Hunting, the percentages of participants in Power Boating (Table 6) increased in all regions between 1967 and 1972. This increase was steady from each survey to the next for three regions: Quebec, Alberta and British Columbia.

Between 1967 and 1972 the percentages of participants in Canoeing (Table 7) increased in all regions except the Atlantic Provinces. Where percentages increased, they did so steadily from each survey to the next except in Saskatchewan. In several regions the increases between 1967 and 1972 were particularly impressive; in Quebec, percentages more than tripled between 1967 and 1972, in Manitoba percentages multiplied by 4.5, in Saskatchewan by four and in British Columbia by four.

Examination of the figures in Table 8 indicates that there were no clear trends for participation in Snow Skiing between 1967 and 1972. However, the increase in participation between 1967 and 1972 was impressive in Manitoba, Saskatchewan and British Columbia.

Percentages of participants in this activity (Table 9) increased in all regions between 1967 and 1972. In almost all regions this increase in participation was impressive, particularly in the Atlantic Provinces where the percentage of individuals who participated in Snowmobiling tripled and in Saskatchewan where it multiplied by almost four. However, British Columbia and Alberta do not seem to have sustained a Snowmobiling "boom".

For all regions the percentages of participants in picnicking (Table 10) increased between 1967 and 1972. However, the 1972 figures are often not as high as the 1969 figures.

As can be seen from Table 11, the five-year participation trend was generally positive for all age groups and for the eight activities considered. However, the following exception should be noted: participation in Hunting declined between 1967 and 1972, for all age groups.

In Table 12 it can be seen that the five-year participation trend (1967 to 1972) was positive for all activities for both sexes with the following exceptions: (a) the five-year trend for Hunting was negative for both sexes; and (b) while the five-year trend (1967 to 1972) for Snow Skiing was slightly negative for males, it was positive for females.

TABLE 6

PERCENTAGE OF INDIVIDUALS 18 YEARS AND OVER WHO DID PARTICIPATE IN POWER BOATING IN 1967, 1969 AND 1972, BY REGION

	1967 %	1969 %	1972 %
Canada	15	19	23
Atlantic Provinces	12	14	13
Québec	11	14	25
Ontario	19	23	23
Manitoba	13	11	22
Saskatchewan	10	23	20
Alberta	13	18	23
British Columbia	20	24	31

TABLE 7

PERCENTAGE OF INDIVIDUALS 18 YEARS AND OVER WHO DID PARTICIPATE IN CANOEING IN 1967, 1969 AND 1972, BY REGION

	1967 %	1969 %	1972 %
Canada	5	8	10
Atlantic Provinces	3	2	2
Québec	3	9	11
Ontario	8	10	11
Manitoba	2	3	9
Saskatchewan	1	9	4
Alberta	6	7	8
British Columbia	3	5	12

TABLE 8

PERCENTAGE OF INDIVIDUALS 18 YEARS AND OVER WHO DID PARTICIPATE IN SNOWSKIING IN 1967, 1969 AND 1972, BY REGION

	1967 %	1969 %	1972 %
Canada	6	7	7
Atlantic Provinces	4	4	2
Québec	8	8	9
Ontario	6	9	6
Manitoba	2	1	6
Saskatchewan	2	4	4
Alberta	7	8	6
British Columbia	7	5	13

TABLE 9

PERCENTAGE OF INDIVIDUALS 18 YEARS AND OVER WHO DID PARTICIPATE IN SNOWMOBILING IN 1967, 1969 AND 1972, BY REGION

	1967 %	1969 %	1972 %
Canada	7	14	18
Atlantic Provinces	6	13	18
Québec	9	21	25
Ontario	6	10	17
Manitoba	7	4	16
Saskatchewan	6	26	23
Alberta	6	15	10
British Columbia	4	2	5

TABLE 10

PERCENTAGE OF INDIVIDUALS 18 YEARS AND OVER WHO DID PARTICIPATE IN PICNICKING IN 1967, 1969 AND 1972, BY REGION

	1967 %	1969 %	1972 %
Canada	42	54	54
Atlantic Provinces	42	50	50
Québec	33	48	46
Ontario	44	56	56
Manitoba	37	38	59
Saskatchewan	57	69	62
Alberta	49	68	61
British Columbia	45	58	55

TABLE 11

PERCENTAGE OF CANADIANS WHO DID PARTICIPATE IN 8 SELECTED OUTDOOR RECREATION ACTIVITIES IN 1967, 1969 AND 1972, BY AGE GROUP

ACTIVITY	AGE GROUP	1967 %	1969 %	1972 %
Tent-camping	30 - 39	17	14	21
	40 - 49	13	12	16
	50+	5	4	4
Trailer-camping	30 - 39	9	6	16
	40 - 49	8	8	12
	50+	3	4	6
Hunting	30 - 39	16	16	12
	40 - 49	13	11	11
	50+	7	5	5
Power boating	30 - 39	16	20	26
	40 - 49	14	17	23
	50+	7	10	12
Canoeing	30 - 39	5	8	11
	40 - 49	4	5	6
	50+	2	3	3
Snowskiing	30 - 39	6	7	8
	40 - 49	5	3	6
	50+	1	2	2
Snowmobiling	30 - 39	6	15	23
	40 - 49	5	11	12
	50+	1	4	5
Picnicking	30 - 39	54	63	62
	40 - 49	45	58	55
	50+	25	36	36

TABLE 12

PERCENTAGE OF CANADIANS WHO DID PARTICIPATE IN 8 SELECTED OUTDOOR RECREATION ACTIVITIES IN 1967, 1969 AND 1972, BY SEX

ACTIVITIES	SEX	1967 %	1969 %	1972 %
Tent-camping	M	16	15	22
	F	11	10	16
Trailer-camping	M	7	5	10
	F	6	6	10
Hunting	M	23	23	19
	F	4	3	3
Power boating	M	17	24	27
	F	12	14	20
Canoeing	M	6	11	12
	F	3	5	8
Snow Skiing	M	8	9	7
	F	5	5	8
Snowmobiling	M	8	17	19
	F	6	11	17
Picnicking	M	36	51	52
	F	47	57	55

Table 13 allows one to see the trends in participation in outdoor recreation by Socio-Economic Level. The socio-economic levels used (Upper, Upper Middle, Middle, Lower Middle and Lower) were determined by the interviewers and are, at best, approximations of objective socio-economic status. The CORD Study Data Documentation Volume contains information on how these level were determined.

The five-year (1967 to 1972) trend was positive for all activities in each socio-economic level with the following exceptions: (a) for Hunting, the trend was negative in each socio-economic level; and (b) for Snow Skiing, the trend was positive for all levels except the Upper Middle level where there was no change from 1967 to 1972.

CHANGE IN THE INCIDENCE OF PARTICIPATION BETWEEN 1969 AND 1972

As is evident from the analysis of the previous data, it is not infrequent that short term fluctuations in participation contradict the long term trends. Analysis of the three-year period fluctuations in participation will not help determine long-term trends but will assist in gaining an insight into the evolution of participation in seventeen outdoor recreation activities between 1969 and 1972.

As can be seen from Table 14, in Canada as a whole between 1969 and 1972, participation decreased slightly in four outdoor recreation activities (Hunting, Visiting Historic Parks/Sites, Driving for Pleasure and Sightseeing from a Private Vehicle); participation remained stable in three activities (Snow Skiing, Picnicking and Horseback Riding) and increased in ten activities out of the seventeen. The increase in participation in Camping with a Pick-Up Camper was particularly impressive (100 percent increase). Incidentally, one should note that the decreases cited are not incompatible with an increase in total activity. Frequency of participation by those who do participate has gone up.

Tables such as Table 14 have been prepared for most provinces and some metropolitan areas and are presented in Appendix B of the special version of this paper cited earlier. However, since here the primary concern is with trends, Table 15 presents a comparison of the Percentage Changes in Participation between 1969 and 1972 for Canada, most provinces and some metropolitan areas.

TABLE 13

PERCENTAGE OF CANADIANS WHO DID PARTICIPATE IN 8 SELECTED OUTDOOR RECREATION ACTIVITIES IN 1967, 1969 AND 1972, BY SOCIO-ECONOMIC LEVEL (U = Upper; UM = Upper Middle; M = Middle; LM = Lower Middle; L = Lower)

ACTIVITIES		1967 %	1969 %	1972 %
Tent-camping	U	14	10	17
	UM	18	18	20
	M	14	13	20
	LM	14	11	20
	L	7	9	18
Trailer-camping	U	8	4	12
	UM	8	8	13
	M	7	6	10
	LM	5	7	9
	L	3	3	7
Hunting	U	13	12	9
	UM	14	14	13
	M	14	11	11
	LM	14	13	11
	L	12	13	11
Power boating	U	22	27	28
	UM	17	23	29
	M	12	16	26
	LM	13	17	20
	L	6	12	13
Canoeing	U	8	13	15
	UM	5	7	11
	M	4	7	9
	LM	4	6	8
	L	2	7	7
Snow Skiing	U	11	16	13
	UM	8	7	8
	M	4	5	6
	LM	4	7	5
	L	2	3	4
Snowmobiling	U	10	14	18
	UM	6	14	21
	M	6	14	19
	LM	6	14	19
	L	5	11	13
Picnicking	U	46	59	59
	UM	51	63	58
	M	39	56	58
	LM	39	52	50
	L	28	42	44

TABLE 14

INCREASE IN THE PERCENTAGE OF CANADIANS WHO DID PARTICIPATE IN 17 OUTDOOR RECREATION ACTIVITIES BETWEEN 1969 AND 1972.

ACTIVITIES	1969 (a) %	1972 (b) %	(b-a) %	$\frac{(b-a)100}{a}$ %
Tent-camping	12	19	7	58
Trailer-camping	6	10	4	67
Pick-up camper	2	4	2	100
Hunting	13	11	-2	-15
Power boating	19	23	4	21
Canoeing	8	10	2	25
Sailing	3	4	1	33
Visiting Historic Parks/ Sites	37	36	-1	-3
Driving for pleasure	67	65	-2	-3
Sightseeing from private vehicle	43	38	-5	-12
Snow Skiing	7	7	0	0
Snowmobiling	14	18	4	28
Picnicking	54	54	0	0
Walking-hiking	37	39	2	5
Ice skating	19	20	1	5
Horseback riding	8	8	0	0
Bicycling	13	19	6	46

TABLE 15

PERCENTAGE INCREASE IN THE INCIDENCE OF PARTICIPATION IN 17 OUTDOOR RECREATION ACTIVITIES BETWEEN 1969 AND 1972, FOR CANADA AND REGIONS

(Percentage Increase = $\frac{(\%\ \text{Participants 1972}) - (\%\ \text{Participants 1969})}{(\%\ \text{Participants 1969})} \times 100$)

ACTIVITIES	Canada	Atlantic Provinces	Nova Scotia	Quebec	Metro Montreal	Ontario	Metro Toronto	Manitoba	Saskat-chewan	Alberta	British Columbia	Metro Vancouver
Tent-camping	58	18	67	38	36	90	112	80	15	47	71	80
Trailer-camping	67	125	75	60	17	150	200	71	-8	200	57	50
Pick-up camper	100	-33	-50	0	100	100	100	400	67	50	150	-12
Hunting	-15	40	162	-17	0	-20	-20	9	-16	-43	-6	-30
Power boating	21	-7	0	78	-60	0	-4	100	-13	28	29	4
Canoeing	25	0	0	22	25	10	27	200	-55	0	140	44
Sailing	33	-40	-56	100	0	50	43	300	-75	-75	250	300
Visiting Historic Parks/Sites	-3	-11	13	0	-22	-2	-13	52	-5	-10	-8	-21
Driving for pleasure	-3	-3	-6	-8	-14	0	-14	8	6	5	-6	-15
Sightseeing from private vehicle	-12	-21	-7	-21	-18	-17	-28	16	-4	0	2	-18
Snow skiing	0	-50	-83	12	17	33	25	500	0	-25	160	114
Snowmobiling	28	38	8	19	-7	70	12	300	-12	-33	150	400
Picnicking	0	0	2	-4	-9	0	4	55	-10	-10	-5	-9
Walking - hiking	5	-7	-13	5	-13	-2	-19	100	-7	20	2	2
Ice Skating	5	-20	-50	6	-9	4	0	83	-6	-39	25	54
Horseback riding	0	25	-67	12	0	0	-38	300	-10	9	11	43
Bicycling	46	22	-31	36	27	54	18	271	56	0	167	238

TABLE 16

PERCENTAGE INCREASE IN THE INCIDENCE OF PARTICIPATION

IN 17 OUTDOOR RECREATION ACTIVITES BETWEEN 1969 AND 1972,

BY AGE GROUP

$$\text{Percentage increase} = \frac{(\%\ \text{Participants 1972}) - (\%\ \text{Participants 1969})}{(\%\ \text{Participants 1969})} \times 100$$

ACTIVITY	18 years & over	Age 18-29	Age 30-39	Age 40-49	Age 50 & over
Tent-camping	58	75	50	33	0
Trailer-camping	67	67	167	50	50
Pick-up camper	100	33	67	200	100
Hunting	-15	-10	-25	0	0
Power boating	21	14	30	35	20
Canoeing	25	13	38	20	0
Sailing	33	33	67	-33	100
Visiting Historic Parks/Sites	-3	8	8	-11	-15
Driving for pleasure	-3	-1	0	-10	0
Sightseeing from private vehicle	-12	0	-7	-31	-18
Snow Skiing	0	-13	14	100	0
Snowmobiling	28	29	53	9	25
Picnicking	0	2	-2	-5	0
Walking/hiking	5	13	-12	-5	11
Ice skating	5	-5	0	8	100
Horseback riding	0	0	40	50	0
Bicycling	46	50	50	25	150

TABLE 17

INCREASE IN PERCENTAGES OF CANADIANS WHO DID PARTICIPATE IN 17 OUTDOOR RECREATION ACTIVITIES BETWEEN 1969 AND 1972, ACCORDING TO SEX

ACTIVITES		1969 %	1972 %	(b-a) %	$\frac{(b-a)}{(a)}$ 100 %
Tent-camping	M	15	22	7	47
	F	10	16	6	60
Trailer-camping	M	5	10	5	100
	F	6	10	4	67
Pick-up camper	M	3	4	1	33
	F	2	4	2	100
Hunting	M	23	19	-4	-17
	F	3	3	0	0
Power boating	M	24	27	3	12
	F	14	20	6	43
Canoeing	M	11	12	1	9
	F	5	8	3	60
Sailing	M	4	4	0	0
	F	3	4	1	33
Visiting Historic Parks/Sites	M	37	36	-1	-3
	F	37	36	-1	-3
Driving for pleasure	M	66	66	0	0
	F	67	64	-3	-4
Sightseeing from private vehicle	M	43	38	-5	-12
	F	43	38	-5	-12
Snow Skiing	M	9	7	-2	-22
	F	5	8	3	60
Snowmobiling	M	17	19	2	12
	F	11	17	6	54
Picnicking	M	51	52	1	2
	F	57	55	-2	-4
Walking-hiking	M	35	36	1	3
	F	40	42	2	5
Ice skating	M	23	22	-1	-4
	F	16	18	2	12
Horseback riding	M	9	10	1	11
	F	6	7	1	17
Bicycling	M	13	19	6	46
	F	12	20	8	67

TABLE 18

INCREASE IN THE PERCENTAGE OF CANADIANS WHO DID PARTICIPATE IN 17 OUTDOOR RECREATION ACTIVITIES BETWEEN 1969 AND 1972, ACCORDING TO SOCIO-ECONOMIC LEVEL.

ACTIVITIES		1969 (a) %	1972 (b) %	(b-a) %	$\frac{(b-a)}{(a)}$ 100 %
Tent-camping	U	10	17	7	70
	UM	18	20	2	11
	M	13	20	7	54
	LM	11	20	9	82
	L	9	18	9	100
Trailer-camping	U	4	12	8	200
	UM	8	13	5	62
	M	6	10	4	67
	LM	7	9	2	28
	L	3	7	4	133
Pick-up camper	U	2	4	2	100
	UM	2	3	1	50
	M	4	4	0	0
	LM	1	4	3	300
	L	2	3	1	50
Hunting	U	12	9	-3	-25
	LM	14	13	-1	-7
	M	11	11	0	0
	LM	13	11	-2	-15
	L	13	11	-2	-15
Power boating	U	27	28	1	4
	LM	23	29	6	26
	M	16	26	10	62
	LM	17	20	3	18
	L	12	13	1	8
Canoeing	U	13	15	2	15
	UM	7	11	4	57
	M	7	9	2	28
	LM	6	8	2	33
	L	7	7	0	0
Sailing	U	9	10	1	11
	UM	3	6	3	100
	M	1	3	2	200
	LM	1	3	2	200
	L	2	2	0	0
Visiting Historic Parks/Sites	U	49	44	-5	-10
	UM	43	44	1	2
	M	36	35	-1	-3
	LM	33	32	-1	-3
	L	25	26	1	4

TABLE 18 (cont'd.)

ACTIVITIES		1969 (a) %	1972 (b) %	(b-a) %	(b-a) 100 / (a) %
Driving for pleasure	U	67	71	4	6
	UM	73	73	0	0
	M	68	68	0	0
	LM	69	64	-5	-7
	L	57	52	-5	-9
Sightseeing from private vehicle	U	51	48	-3	-6
	UM	50	43	-7	-14
	M	44	40	-4	-9
	LM	40	34	-6	-15
	L	31	28	-3	-10
Snow Skiing	U	16	13	-3	-19
	UM	7	8	1	14
	M	5	6	1	20
	LM	7	5	-2	-28
	L	3	4	1	33
Snowmobiling	U	14	18	4	28
	UM	14	21	7	50
	M	14	19	5	36
	LM	14	19	5	36
	L	11	13	2	18
Picnicking	U	59	59	0	0
	UM	63	58	-5	-8
	M	56	58	2	4
	LM	52	50	-2	-4
	L	42	44	2	5
Walking-hiking	U	45	49	4	9
	UM	36	41	5	14
	M	39	41	2	5
	LM	39	36	-3	-8
	L	31	31	0	0
Ice skating	U	28	23	-5	-18
	UM	20	27	7	35
	M	19	19	0	0
	LM	18	17	-1	-6
	L	15	15	0	0
Horseback riding	U	7	8	1	14
	UM	6	10	4	67
	M	8	9	1	12
	LM	11	8	-3	-27
	L	6	7	1	17
Bicycling	U	15	23	8	53
	UM	11	22	11	100
	M	12	21	9	75
	LM	13	17	4	31
	L	12	14	2	17

TABLE 19

FREQUENCY OF PARTICIPATION IN OUTDOOR RECREATION ACTIVITIES BY CANADIANS 18 YEARS AND OVER. COMPARISON OF THE 1969 AND 1972 8M SURVEYS.

ACTIVITY	FREQUENCY OF PARTICIPATION	1969 %	1972 %
Swimming	Not at all	56	-
	1-5 times	17	-
	6-10 times	10	-
	More than 10 times	17	-
Tent-camping	Not at all	88	81
	1-5 times	9	14
	6-10 times	2	2
	More than 10 times	1	2
	Not stated	-	1
Trailer-camping	Not at all	94	90
	1-5 times	4	6
	6-10 times	1	1
	More than 10 times	1	2
	Not stated	-	1
Pick-up camper	Not at all	98	96
	1-5 times	1	2
	6-10 times	-	-
	More than 10 times	-	-
Hunting	Not at all	87	89
	1-5 times	10	7
	6-10 times	1	2
	More than 10 times	2	2
Power boating	Not at all	81	77
	1-5 times	11	12
	6-10 times	3	4
	More than 10 times	5	6
	Not stated	-	1
Canoeing	Not at all	92	90
	1-5 times	6	6
	6-10 times	1	1
	More than 10 times	1	1
	Not stated	-	1
Sailing	Not at all	97	96
	1-5 times	2	3
	6-10 times	-	1
	More than 10 times	-	-

TABLE 19 (Cont'd.)

ACTIVITY	FREQUENCY PARTICIPATION	1969 %	1972 %
Water skiing	Not at all	93	-
	1-5 times	5	-
	6-10 times	1	-
	More than 10 times	1	-
Nature study or bird watching	Not at all	88	-
	1-5 times	7	-
	6-10 times	2	-
	More than 10 times	3	-
Outdoor Photography	Not at all	76	-
	1-5 times	13	-
	6-10 times	6	-
	More than 10 times	5	-
Visiting Historic Sites/Parks	Not at all	63	64
	1-5 times	30	27
	6-10 times	4	4
	More than 10 times	3	3
	Not stated	-	2
Visiting other Parks	Not at all	59	-
	1-5 times	33	-
	6-10 times	5	-
	More than 10 times	3	-
Driving for pleasure	Not at all	33	35
	1-5 times	21	11
	6-10 times	17	12
	More than 10 times	29	36
	Not stated	-	6
Sightseeing from private vehicle	Not at all	57	62
	1-5 times	24	14
	6-10 times	8	6
	More than 10 times	11	14
	Not stated	-	4
Climbing	Not at all	95	-
	1-5 times	4	-
	6-10 times	1	-
	More than 10 times	-	-
Snow Skiing	Not at all	93	93
	1-5 times	3	3
	6-10 times	2	1
	More than 10 times	2	3
Snowmobiling	Not at all	86	82
	1-5 times	8	8
	6-10 times	2	3
	More than 10 times	4	6
	Not stated	-	1

TABLE 19 (Cont'd.)

ACTIVITY	FREQUENCY OF PARTICIPATION	1969 %	1972 %
Snow sledding/ tobogganing	Not at all	85	-
	1-5 times	10	-
	6-10 times	3	-
	More than 10 times	2	-
Picnics or cookouts away from home	Not at all	46	46
	1-5 times	31	26
	6-10 times	13	12
	More than 10 times	10	12
	Not stated	-	4
Walking/hiking	Not at all	63	61
	1-5 times	17	11
	6-10 times	9	7
	More than 10 times	11	18
	Not stated	-	3
Golfing	Not at all	89	-
	1-5 times	5	-
	6-10 times	2	-
	More than 10 times	4	-
Ice skating	Not at all	81	80
	1-5 times	10	10
	6-10 times	3	4
	More than 10 times	6	5
	Not stated	-	1
Horseback riding	Not at all	92	92
	1-5 times	6	6
	6-10 times	1	1
	More than 10 times	1	1
	Not stated	-	-
Bicycling	Not at all	87	81
	1-5 times	7	8
	6-10 times	3	3
	More than 10 times	3	7
	Not stated	-	2
Tennis	Not at all	94	-
	1-5 times	3	-
	6-10 times	1	-
	More than 10 times	2	-
Fishing	Not at all	-	69
	1-5 times	-	16
	6-10 times	-	6
	More than 10 times	-	7

One can see from Table 15 that the range and direction of variation in the changes was quite great from one activity to another and from one area to another. Hence, there was only one activity, Tent-Camping that had known increases in percentages of participants in all areas between 1969 and 1972; these increases range between 15 percent for Saskatchewan and 112 percent for Metropolitan Toronto. However, the reader should take note of the points made in the special section after the Introduction. These should have led the reader to expect that much of the fluctuation observed in Table 15 is of a statistical nature and related to small sample size. Moreover, there was only one area, Manitoba, that had increases in percentages of participants in all seventeen activities between 1969 and 1972. These increases ranged between 8 percent for Driving for Pleasure and 500 percent for Snow Skiing.

Of the 204 entries in this Table, 76 (37 percent) show a decrease in participation, 18 (9 percent) show no change and 110 (54 percent) show an increase.

The decreases seem dispersed throughout areas and activities. However, decreases in the four following activities were widespread throughout Canada: Visiting Historic Park/Sites (decreases in 9 areas out of 12 between 1969 and 1972), Driving for Pleasure (8 areas out of 12) and Hunting (8 areas out of 12). As well, in Saskatchewan between 1969 and 1972 there were decreases in participation in 12 of the 17 outdoor activities.

The comparability of the 1969 and 1972 data permits analysis of the evolution of participation in seventeen recreation activities between 1969 and 1972 for four Age Groups: 18-29, 30-39, 40-49 and 50 and over.

Of the 85 entries in this table, 20 (24 percent) showed decreases in participation between 1969 and 1972, 15 (18 percent) showed no change, and 50 (58 percent) showed an increase in participation between the two periods.

Even if decrease in participation is not concentrated in any particular Age Group, it is in Age Group 40 - 49 that decrease is most often noticed, i.e. in six activities out of seventeen. It may also be noticed that while decrease in participation for Hunting is concentrated in the 18 - 29 and 30 - 39 age groups, the pattern is quite different for Visiting Historic Parks/Sites where decrease in participation between 1969 and 1972 occured in the 40 - 49 and 50 and over age groups.

Results shown in Table 17 suggest that even if trends for most activities were positive for both males and females during the 1969 - 1972 period, increase in percentages of Canadians who participated in outdoor recreation activities may be quite different according to sex. For instance, while the percentage change in Snow Skiing for males was negative (22 percent decrease), for female it was positive (60 percent increase).

Even if the socio-economic levels used were determined subjectively by the interviewers, this classification may help in gaining insight into class patterns of participation

in outdoor recreation activities. As shown in Table 18, between 1969 and 1972 there was a great range in the percentage increases in participation from one activity to another and from one socio-economic level to another. There does not, however, seem to be any generalized pattern that applies to these changes in percentage participation according to economic level. It may be that a more objective sociosocio-economic scale would give greater insight.

CHANGE IN THE FREQUENCY OF PARTICIPATION BETWEEN 1969 AND 1972

The 1969 and 1972 surveys present information not only on the incidence of participation in outdoor recreation activities but also on the frequency of participation. These results are shown in Table 19. When considering only the seventeen activities for which there is information on the frequency of participation for 1969 and 1972, it can be seen that the "more than 10 times" has a somewhat greater percentage for five activities and a lower percentage in 1972 than in 1969 for one activity, Snow Skiing. These findings suggest not only that the incidence of participation increased for most outdoor recreation activities between 1969 and 1972 but also that the frequency of participation slightly increased for most activities.

CONCLUSION

Participation in outdoor recreation activities is generally increasing. This is evidenced not only by increases in incidence of participation but also by increases in frequency of participation. The analysis of data for a five-year period shows that for seven activities of the eight that could be considered, the trends in incidence of participation were on the rise between 1967 and 1972, even if there were fluctuations between 1967 and 1969 or between 1969 and 1972. In fact, with some few exceptions, the statement is true for all regions and all age groups considered, for both sexes and for all socio-economic levels.

Changes in percentages of various populations who were participants in seventeen outdoor recreation activities between 1969 and 1972 were positive changes. In Canada as a whole there were increases for ten activities out of seventeen and decreases for four activities. However, when considering regional patterns, one notices that between 1969 and 1972 there was only one activity, Tent-Camping for which increases occurred in all regions. As well, there was only one province, Manitoba, for which increases occured in all activities.

Obviously the evolution of participation in outdoor recreation activities does not follow the same pattern throughout all Canadian regions, at least in a short period.

Yet, having small samples with which to work limited what can be said about regional variations. The analysis of change in percentages of participation by age groups, sex and socio-economic levels, does suggest that there may be important differences in patterns of change according to people's socio-economic characteristics. For example, while there was a 22 percent decrease in percentage of participants in Snow Skiing for males between 1969 and 1972, there was a 60 percent increase for females.

Even if the general impression is that of upward trends in participation in outdoor recreation activities, it would not be accurate to neglect the importance of downward trends. Hunting is the only activity out of the eight considered for 1967, 1969 and 1972 for which there was a steady decrease in percentage of participants in Canada as a whole. Even with the consistent trend just noted, the decrease in Hunting did not occur in two provinces. However, the decrease is consistently observed for Age Groups, Sex and Socio-economic Levels. Between 1969 and 1972, Hunting, Visiting Historic Parks/Sites, Driving for Pleasure and Sightseeing from a Private Vehicle had downward trends in Canada as a whole and in most regions. In Saskatchewan, the percentages of participants declined for twelve out of seventeen activities during that period. Decreases in Saskatchewan may be related to the changing age distribution of the province.

It was not the goal of this paper to explain why, in a general context of increasing participation in outdoor recreation activities in Canada, there are activities or sections of Canadian society that show some decrease in participation, at least in the short term. However, the fact that this brief review of tabulations that were available in the Spring of 1973 raises some interesting questions (as well as bringing together some figures that may be useful to planners) points up the need for a thorough and rigourous analysis of the National Survey data on which the tabulations used in preparing this document are based.

STATISTICAL PROJECTIONS THAT GO BEYOND PROJECTIONS OF PAST TRENDS

J. Beaman

ABSTRACT

This paper deals with one aspect of making projections: the use of quantitative models that allow one to consider certain types of social change. The general idea behind making projections using an equation like the one following is explained:

Probability of participation in an outdoor recreation activity

=

General mean + Income effect + Age effect + Education effect + Family Composition effect + Urbanization effect.

The author discusses the numerous considerations that relate to using such an equation. These are: (1) the accuracy of the estimates that are made; (2) the problems that arise because of the inadequacy of models due to the existence of interaction effects; (3) the need to consider supply in making estimates by introducing a further term into the equation that reflects amount of supply; (4) the need to consider time budget and purpose of participation factors; (5) the failure of the model to "work" where spontaneous change is involved as opposed to change that is either captured in demographic trends or trends in the model coefficients.

In discussing these points the author refers to a number of research projects which have clarified such matters as what the accuracy of certain projections is, how important interaction effects are, how supply may be considered in using the kind of equation specified.

In concluding portions of the article the author acknowledges the relevance of "futures research" techniques such as the delphi method. There is an attempt to show what the relative role of the quantitative method endorsed should be versus (1) simple trend projection and (2) "qualitative" futures research techniques.

As a general guide the author proposes that trend extrapolation is good for one to three year projection. Even though the analysis of variance technique can be used, it is

not suggested because its use is more complicated than trend extrapolation. The analysis of variance technique with very good models is appropriate as the only projection technique to be used for "stable" activities for up to 20 years. When forecasts are of what will happen more than 20 years in the future or when "unstable" activities are considered it is proposed that delphi forecasting be used in conjunction with analytic methods.

PURPOSE

The purpose of this paper is to discuss the making of projections using models that have some projective efficacy because they tap "demographic" components of trends.

AN INTRODUCTION TO THE PROJECTION STRATEGY ENDORSED

As indicated later, the author acknowledges the limitations of classical quantitative methods. Therefore, in what follows, the reader should not get the idea that the author is only endorsing the use of "quantitative" methods. The relevance of work cited in Linstone and Turoff (see Reference 11) and other articles and books are seen as very relevant to one aspect of the problem which is being considered, for example, Mitroff and Turoff (Reference 12), Churchman (Reference 3), Turoff (Reference 16) and Greenall (Reference 9). This paper divides "standard quantitative" projection techniques into two large classes: (1) ad hoc, or the use of a trend line extension from existing historical or time series observations, and (2) structural, or the use of explanatory regression equations that take into account age, income, family size, etc. as variables causally related to recreation participation.

For example, quantitative analysis methods associated with the use of structural models that "tap" the influence of socio-economic factors on specific groups allow one to take into account demographic as well as other trends such as changing age composition of a population, changing sex composition and changing urbanization.

The values in Figures 1 and 2 are the coefficients necessary for defining equations for predicting participation in hunting and snowmobiling. Figure 1 shows that there is a strongly negative relationship between urbanization and participation in hunting. One sees that age effects (shown above the label AGE on the Y-axis) decreases from about .13 for males around 20 years of age to -.14 for males 65+. In Figure 2, one can note similar age effects on snowmobiling. Information on the data used in deriving the coefficients for Equation 1 that are plotted in Figure 1 is provided in TN 12. Literature on the use of such equations in recreation research is also cited there.

In words, the equation developed in TN 12 is based on the idea that:

FIGURE 1

RELATIONSHIP BETWEEN PARTICIPATION/NON-PARTICIPATION IN HUNTING AND SELECTED SOCIO-ECONOMIC CHARACTERISTICS

(FOR MALES)

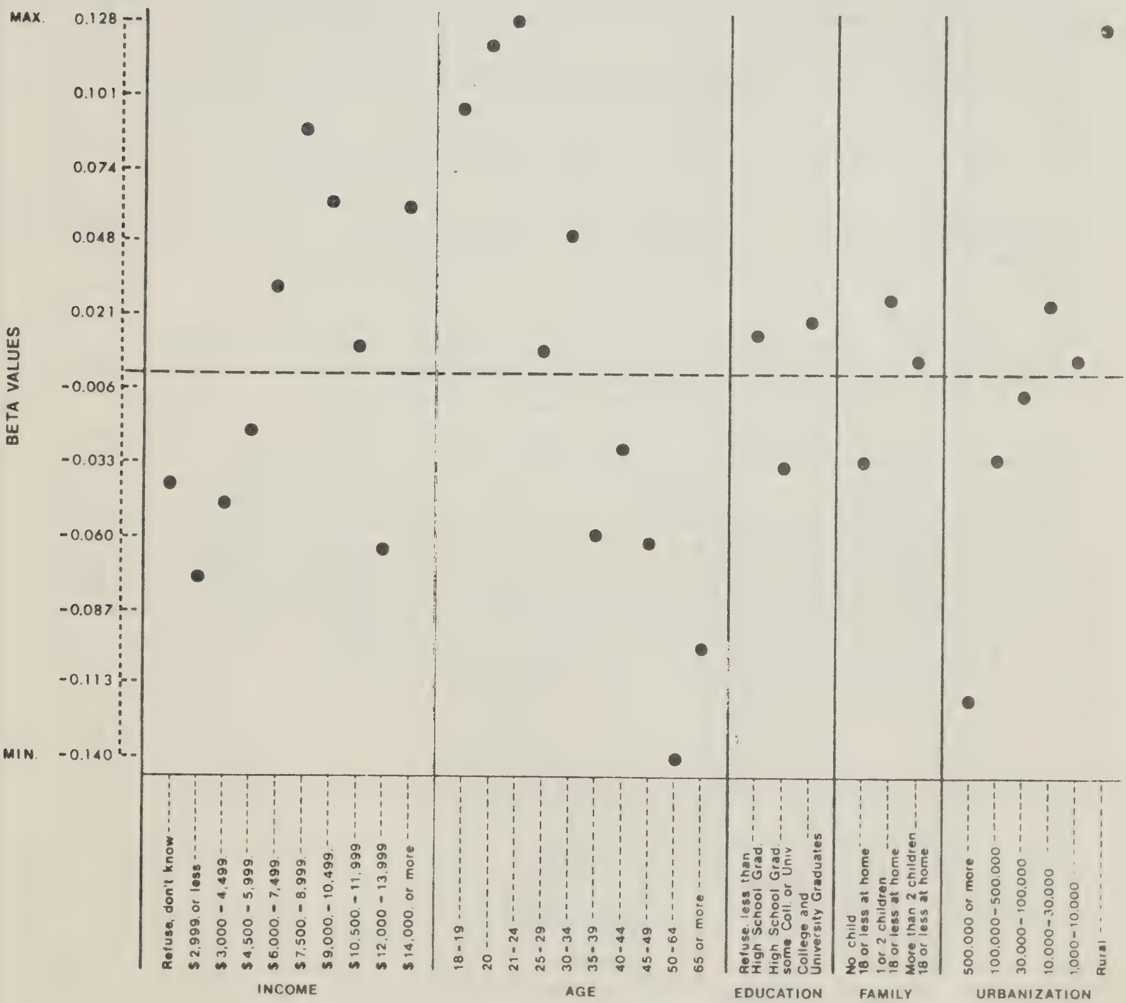
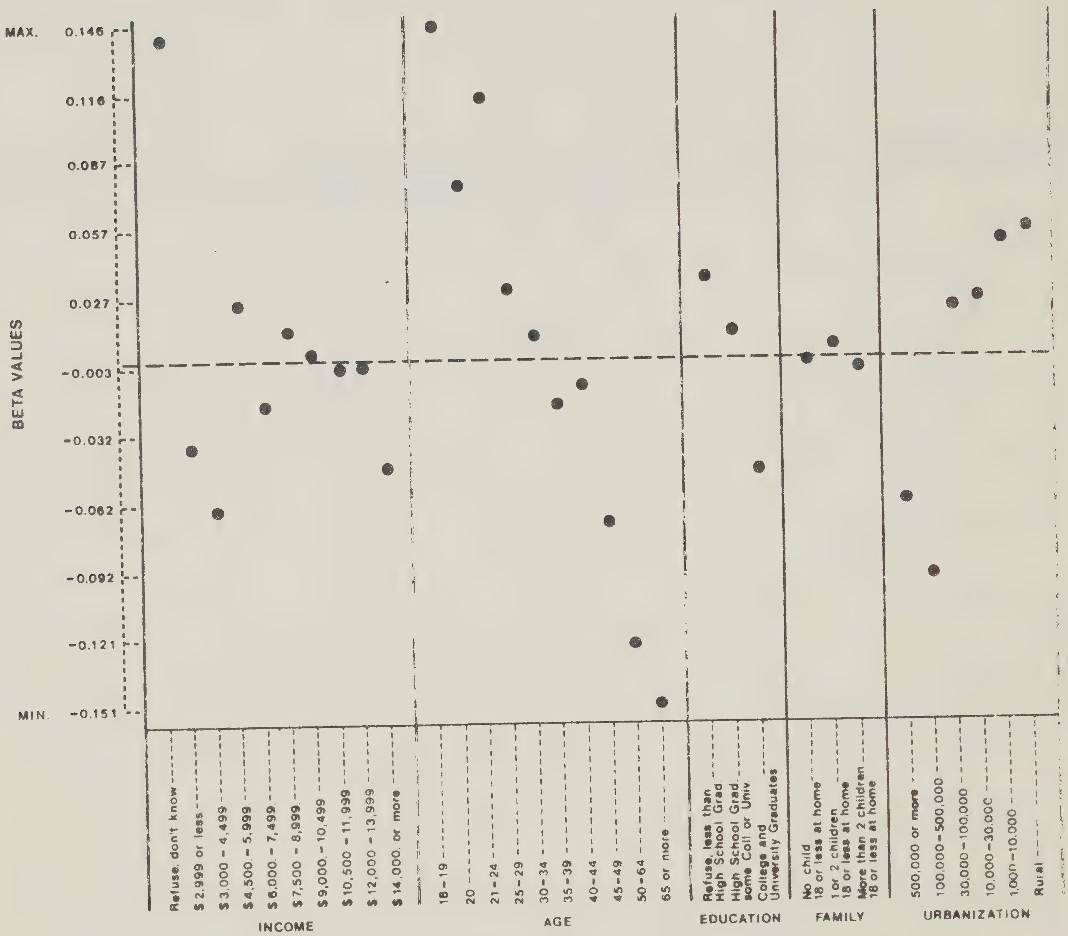


FIGURE 2

RELATIONSHIP BETWEEN PARTICIPATION/NON-PARTICIPATION IN SNOW MOBILING AND SELECTED SOCIO-ECONOMIC CHARACTERISTICS

(FOR MALES)



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(1)

Probability of participating in an outdoor recreation activity

=

General mean + Income effect + Age effect + Education effect + Family compostion effect + Urbanization effect.

As described in TN 12, it is possible to go from such an equation for an individual to an equation for predicting participation for a population:

(2) NP = UT + @E B(1,J)n(1,J) + ... @E B(5,Q)n(5,Q)

WHERE NP = the number of participants in an outdoor recreation activity in the population considered,

U = the general mean for an activity,

T = the number of persons in the population considered,

B(1,J)...B(5,Q) = the effect of an individual being in a category J...Q of socio-economic variables 1...S,

n(1,J)...n(5,Q) = the number of persons in the population considered who are in a category J...Q of socio-economic variable 1...5.

It is important to note that the "urbanization" effects shown in Figure 1, when used in Equation 2, suggest that an increase in urbanization will result in a decreasing participation in hunting even though the effects (coefficients) shown graphically in Figure 1 may remain constant in the future. Specifically, Equation 2 indicates that the number of people participating in hunting in a given year in Canada depends on: (1) the population of Canada in the given year; and, (2) the number of people in various socio-economic groups.

Other shifts, beside urbanization, in the population include aging of the population and increasing education levels. In Figures 1 and 2 the effects shown above the headings Age, Education and Urbanization suggest that being old, highly educated and/or being in an urbanized area are associated with negative effects on hunting participation. Thus three demographic shifts result in an increase in the number of people having negative differentials for participation in hunting. These demographic shifts in the population "explain" the decrease in the number of hunters.

Total Population is the only variable in which there is a change which raises the total number of hunters. However,

since Canada's population growth rate is approaching zero, there is good reason to believe that in ten years, with another ten per cent urbanization in Canada, there will be a decrease in hunting participation larger than the -3.59% and -5.5% "decline" rates for hunting obtained from the Canadian Outdoor Recreation Demand (CORD) Study data (see TN 22). Percentage growth rates are the average annual change in the per cent participating per year. For example, percentage growth rate 1967 to 1969 = 100 ((14% participating in 1967 - 13% participating in 1969)/ (2 years from 1967 to 1969))/14% participation in 1967 = 3.5%.

In the context of the kind of change in hunting participation described above, one can "understand" what is happening when trends in certain activities are observed. Without either going to a Delphi panel or having the results of several surveys providing data for a trend line, it is possible that reasonable and reliable predictions can be made. In fact, an important point is that the trends in rates obtained from surveys may indicate a certain rate of increase or decrease in participation in an activity that is actually reflecting the way that changes in the age distribution, urbanization and income, etc. of a population are interacting to produce rates that are observed in the years considered.

When a structural projection is made in which socio-economic characteristics are independent variables, one need not rely on drawing trend lines through points that are determined by complex interactions of demographic factors. Rather, one can take into account the changes in socio-economic variables that may be expected to occur in the future. And, in this regard, it is important to note that socio-economic changes may be projected by accepted "sound" methods or are even available from central statistical organizations (e.g. Statistics Canada) so it is possible, with some confidence and in some cases little effort, to see what future participation in recreation activities will probably be.

SOME CONSIDERATIONS CONCERNING THE USE OF THE PROPOSED PROJECTION STRATEGY

Accuracy of Estimates

One obvious evaluation criterion to employ when considering the use of the kind of projection approach endorsed here is whether the coefficients that must be used in the model can be determined accurately enough that they could be used in making projections. CORD TN No. 6 has been developed on this topic so there is little need to discuss the issues that are covered there in detail. However, there are a few points which can be noted without entering into lengthy discussion. Firstly, an important determinant of the accuracy of coefficients is the size of the sample on which a model is based. A second important factor to consider is

whether the socio-economic variables that are used in a model are strong determinants of participation in a given activity. This is particularly important since some activities that have a low level of participation may also only have very weak relationships to socio-economic characteristics. Thus, extremely large sample sizes in terms of a random sample from the population of Canada or a particular area may be required to develop certain models.

One might suspect that the size of the area for which projections are made would be important in relation to the accuracy of estimates that can be achieved. However, inaccuracy in estimates of participation in relation to the size of an area for which estimates are made reflect only inherent variability in levels of participation in relatively small populations. The fact that very highly variable levels of participation for small populations may be noted in surveys and expected when projections are made need not, and usually would not, reflect a deficiency of the modelling approach. It would reflect a reality of dealing with small populations.

The preceding comments have been based on an analysis of variance model like the one introduced earlier. But the CORD Study work has already established the effects of certain interaction effect variables that were not considered in the simple models presented in TN 12. Technical Notes have been prepared which show the structural problems of models by pointing out (1) the importance of interaction effects between socio-economic variables in explaining participation in outdoor recreation activities (see TN 20) and (2) the effect of the quantity and quality of supply of facilities on individuals' frequency of participation (see TN 2, 3, 9 and particularly 29; also see the concluding remarks in the review of Chapter VII of this volume).

There is reason to suspect that model coefficients are changing. Over time, changes in the time budgets of people, for example the rise in the number of three-day weekends, may effect coefficients of many variables. Also, exogenous influences not directly related to socio-economic characteristics, such as the energy crisis and innovations in outdoor recreation equipment, certainly result in a changing environment in which people recreate.

Finally, research on National Survey data collected in Canada has shown that there is a clustering of people according to the activities in which they participate (see Reference 14 and the Annex to TN 10). This clustering reflects the situation that exists because there are large numbers of people who participate in very few similar activities, and a few people who participate in very many activities. The existence of the clustering phenomena suggests that, ultimately, analysis of variance models (and other models that pose a basically linear structure as explaining participation in an activity based on characteristics of individuals in a population rather than considering equations for sub-groups of the populations)

will have very serious limitations in terms of making accurate predictions. Limitations relate to problems with the structure of the linear model and its inability to respond in a correct way to changes in the characteristics of the population in terms of the manner in which these changes are occurring. This results in inaccuracy in estimates of participation (see the Future's section of TN 32).

Model structure and the resultant problems that arise when a model is not properly structured has been a recurring theme in the preceding comments. Some specific discussion sections may help the reader see the nature of special "accuracy" problems caused by improperly structured models. These sections may also help the reader see why certain lines of research were pursued in the CORD Study to try and overcome structural problems with models.

Interaction Effects

Interaction effects have received some limited attention in the analysis of recreation behaviour. In the Meuller and Gurin report of the ORRC Study (see Reference 13) analysis of variance runs for males and females were carried out separately because it was recognized that there was a male-female interaction that would have invalidated the results of an analysis including both males and females. There are a few articles that incorporate interaction effects into the development of models to explain participation in outdoor recreation (see Reference 17 and TN 27). On the whole, however, there has not been a concerted effort to discover which interaction effects usually occur in relation to participation in certain activities, or how to deal with these effects.

The essence of the problem is that if, for example, an age-education interaction is important in explaining participation in hunting (as AID runs with Canadian National Survey data have indicated), then part of the variance that could have been explained by an appropriately structured analysis of variance model is not explained if the model derived does not contain interaction effects. Such a structurally deficient model not only does not explain all the variance that could be explained, it obviously cannot provide any insights into a system in which interactions are occurring. Thus problems may arise when the model is applied using an equation similar to Equation 3. Using socio-economic projections of a population for some later time, the effects on participation resulting from changes in the distribution of people in various expected age-education categories will not be accounted for properly.

If the structure of a model does not reflect the way people behave, but is simply molded to fit a set of static data, it should not be expected to provide a valid representation of some future reality. Specifically, (1) models' efficacy in predicting future patterns is lowered and (2) questionable trends may be imputed from the data.

The magnitude of these problems depends on the degree of interaction in the portion of the population which is being modelled. Generally, what is the extent of interaction? Preliminary results obtained from Canadian National Survey data indicate that the interaction effects involve a sum of squares (a measure of explanative power) as large as the sum of squares associated with the first order effects, even when analyses are run separately for males and females (see TN 20).

Supply Considerations

Researchers have known for a long time that the supply of facilities for participation in an outdoor recreation activity affects the amount of participation that occurs. However, the exact nature of this relationship has not been established. The work on demand functions for outdoor recreation at reservoirs and similar work on demand functions for parks has cast some light on the relationship between supply and participation. However, most demand function models do not treat supply in a way that allows one to generate figures for the total amount of participation that will arise in a city that is surrounded by a variety of units of supply at various distances (for example, see the literature on demand function models cited in Reference 5).

Cicchetti, et al. (see Reference 4) have developed an equation that shows the relationship between supply and participation in activities in a given origin area. Because of the unavailability of data for specific locations where people participated, Cicchetti's equation applies only to aggregate supply. Thus it was not possible to include any locational or distance effects on the supply factor. It follows that if one attempts to develop a model similar to Equation 3, it should contain a supply component in addition to various socio-economic characteristics. This supply factor should reflect the relative level of supply of facilities for a given activity that is available to the relevant population.

If a model is developed without a supply factor as an independent variable then the same problems arise as when a model is developed without a measurement of the interaction effects. As noted in the last section, part of the variance that could be explained by the model is not. This variance either (1) turns up being counted as error when it is, in fact, systematic, or (2) causes distortion in the coefficients of the model. The result will be invalid projections when the model is applied to both (a) participation estimation for specific areas that deviate from some norm such as the average national supply of National Parks and (b) projections of participation for five or ten years for a given area in which the quantity or quality of supply change.

In recognition of the considerations noted above, some CORD Study analysis work has been on the development of the supply factor model (see TN 29). Resources have also been

devoted to work on modelling considerations that generalize the Cesario origin destination flow model (see TN 33). Promising results have already been achieved in the supply factor modelling effort. The work related to the Cesario model is of a much more general nature and offers a promise of allowing an understanding of the structure of relations involved when a new site is "plugged in" among a group of alternative sites and when people modify their behaviour in relation to alternative sites which are available.

But when one refers to alternatives being available, two issues arise. If there exists a system of parks and a new, similar park is created, then an alternative to the existing parks has been created. However, it is recognized that there are alternatives to visiting parks in terms of outdoor recreation behaviour. Burton (Reference 2) and Gillespie (Reference 7) have discussed a methodology for the determination of the substitutability of activities by the use of a factor analysis procedure. Hendee and Burdge (Reference 10) have reviewed a large number of considerations related to the substitutability of one activity for another (also see Reference 00 for Beaman's comments on the Hendee and Burdge article). In discussing apparent trade-offs between activities, Beaman and Leicester (see TN 37) suggest that one should be careful to recognize that there are substitutable and complementary activities, activities such that if people participate, they tend to participate in both of the activities or neither. One need only review the works already cited here or by Bishop and Witt (Reference 1), which are devoted to operationalizing the Ontario TORPS (Travel and Outdoor Recreation Planning Study, Reference 6) to see how many academic challenges and practical problems relate to understanding substitutability.

Regarding supply considerations, the cluster analysis work (see Reference 14 and TN 10) has implications for participation in, and trade-offs between, activities. Some of the implications of clustering analysis and problems in using factor analysis in determining trade-offs or complementarity between activities are noted in TN 32. The main point here, however, is that a cluster analysis model is a drastically different model than a linear additive model. The way in which people respond to supply when there is an intricate interrelationship between supply and a collection of activities in which people have participated is simply not "explained" by a group of linear models. Obviously the supply for any number of activities interacts with other participation variables to produce observed behaviour and when a number of supply units for a number of facilities relate to how decisions are made, there is a complex non-linear situation (see the "trade-off" matrix specified in Reference 1.)

Though important work is proceeding on the effect of supply on participation, the results are not yet definitive. It must therefore be recognized that models are still deficient in terms of the way that supply is introduced into the modelling framework. The result is that it is still

necessary to "live with" some structural error related to supply and behaviour (see the concluding remarks of the review of Chapter VII).

Time Budget and Purpose of Participation Considerations

Implicit in much of what has been suggested about changing patterns of behaviour and the effect of socio-economic variables is a concern with time budgets. One component of the supply base for any activity is the availability of time to participate in that activity. The potentially drastic effects on participation in any number of activities if there is a shift to a three- or four-day week is obvious. It is very likely that activities participated in during the week involving little travel may be ignored in favour of activities involving more travel. But very little demand research has rigorously considered expenditures of time and changing supplies of time as these affect recreation consumption. Thus, it would be pretentious to claim that any recreation research effort has provided a really usable way of entering time budget information into a supply-demand or supply-participation model (for general time budget research, see Reference 15). The amounts of discretionary time, the kind of packages in which it is available and the availability of resources to use this time have fundamental implications for the amount of participation in outdoor recreation activities that will occur (for a classical discussion, see Reference 8). Until better theoretical work is developed and better data sets are available for analysis, time budget considerations will enter into the participation models in a very inadequate way. Thus, the incorporation of time budget information for tapping important trends in time use cannot be expected to be realized in the near future.

The only way it now seems possible to structure models to explain some of the trends to the change in time budgets is to include gross or aggregate time use information in models. In Canada, two time budget data sets exist that can be used in model development (Halifax time budget data collected by members of the Dalhousie Institute of Public Affairs and Vancouver data collected by members of the Department of Sociology, University of British Columbia).

"Spontaneous" Change vs Trends In Model Coefficients

Understanding trends in the coefficients that define structural models is much more complicated than recognized in time budgets as showing sources of variation. The discussion above has suggested that models do not adequately consider changes in time budgets and supplies of facilities. Furthermore, these models have been shown to ignore interaction effects and how these change model coefficients over time. Implicit in the discussion, however, is the notion that in theory all these sources of change in the coefficients can be understood and controlled.

Though this paper endorses seeking an understanding of the structure of relations that "explain" behaviour, several practical non-structure oriented procedures can be suggested for making necessary projections. First, when several surveys are available that are large enough that model coefficients have small standard deviations compared to their magnitude, then trends in regression coefficients over time should be considered so that, as well as projecting demographic characteristics, relevant projection coefficients may be projected. The author considers this a case where demographically induced trends, and trends in the related coefficients, may be used in a rigorous way for making projections. This may be done by using both projected coefficients and projected population characteristics in Equation 3 or a generalization of this equation to include supply factors and interaction effects.

Another consideration relates to what might be called "spontaneous change". Innovation in a given area may result in the development of the snowmobile or a device that has not yet been marketed. Obviously trends in participation in presently marginal activities or activities of the future cannot be extrapolated to suggest future participation in these activities. It is in these cases that demographically induced trends are irrelevant to predicting future levels of participation unless participation in one activity is traded-off with another. In this case, valid projections may be made for aggregates of activities but not for specific ones in a collection of activities among which trade-offs are occurring.

In the context of specific established activities, looking at demographically induced trends may be relatively useful while this approach has little to offer in the context of new or unthought of activities. For these activities, the use of the Delphi technique or other futuristic projection techniques offer the only use alternatives. The boom in snowmobiling was not predictable in 1930 in the sense that 45 years ago one could not have looked at certain coefficients, age distributions, etc., and have predicted the present level of snowmobiling. Further, it is almost certain that even with data on snowmobiling in 1969 and 1972, one cannot come up with realistic projections based on current trends and betas of what snowmobiling will be in 1990. Snowmobiling in 1969 was in a transition period and it is questionable whether some equilibrium had been reached only three years later.

CONCLUSION

In this paper, two kinds of participation projection models have been identified. The one which is of major concern is the structural model which explicitly considers change in participation as being directly linked to socio-economic changes in the populations under consideration. This type of change may be described as resulting in

"demographically induced trends" in participation rates.

When several surveys on participation rates and demographic trends are available, appropriate structural parameters can be estimated and trends in these parameters can be established. Given the expected future values of these parameters, it becomes possible to project future participation levels. This is a logical extension of the assumption that coefficients observed at a given time are relatively stable, and thus are valid and reliable enough to apply five, ten or twenty years in the future.

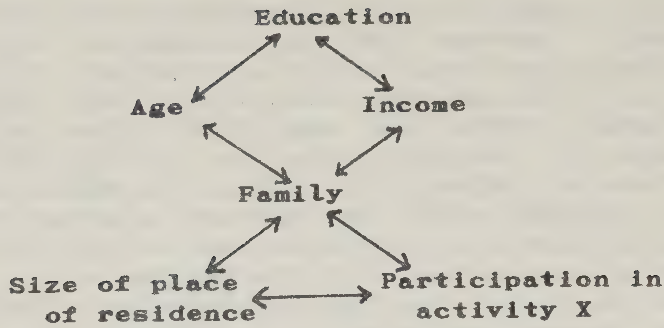
The author believes that when demographic changes are the predominant reason for changing participation levels, there is good reason to argue that accurate projections of participation in the future will only be achieved by the procedures endorsed here, rather than by simply projecting an observed trend in a dependent variable. However, if a planner is interested in future levels of new activities (e.g. sky-diving or snowmobiling, or the future importance of currently non-existent activities which can be expected to grow out of future technologies and fads) then the "demographically induced trends" projection approach is either too risky or impossible.

Problems in operationalizing the demographic trends approach are due to:

1. accuracy of model coefficients;
2. problems with model structure; and,
3. changing model structure over time.

Therefore, it means that it is necessary to evaluate (a) all projections made on the basis of common sense, (b) "check" projections made by comparison with simple trend projections, (c) make re-evaluation of models as new data, allowing new parameter estimates, become available, and (d) evaluate and revise models as new research results become available allowing improvement of models with existing data.

Finally, many readers may find it surprising that in this paper there has been no discussion of causal modelling. Obviously, one problem with the kind of model discussed earlier is that the variables do not have the reciprocal non-causal relation implied by considering all the independent variables as exogenous. It is really only a matter of priorities and time that has prevented the use of path analysis on the econometric method of multiple-stage least-squares to further clarify how models should be structured. Certainly the author is interested in seeing the value of path coefficients for a model like that below:



Incidentally, in the above the rather strange "role" of age reflects the fact that age with cross sectional data for a given year at a given point in time reflects the generation and values of a generation by its relation to year of birth.

In other words, many research steps remain to be taken before the general projection procedure discussed here becomes a tested tool for use by a technician. Projection is still partially "art" as well as "science". A researcher or planner should be willing to abandon any "accepted" projection methods which have more problems than those that were described for the modelling approach. It is necessary to continually update and revise the professional's repertoire of modelling techniques as improvements are made. Unlike many engineering fields, recreation's "accepted techniques" are generally far from totally satisfactory for even "simple" problems.

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Taking the two notes in order, one should note that many of the deficiencies of TN 22 are obvious. There are no indications of which trends cited in the paper are real and which are statistical. There should have been a consideration of reliability - at least of statistical reliability - so that the reader would know what the variances are in the various numbers presented. Furthermore, there should have been a discussion of validity.

Before pursuing these issues further, it is fair to point out that this paper was put together early in the analysis stage of the CORD Study. What is more, at one point estimates of statistical error in various observations were prepared but they were never incorporated into the paper because by that time interest had diminished and it was not considered worthwhile re-writing the paper with statistical accuracy estimates.

One of the chief reasons for this was the results of the validity analysis presented in TN 24. In contrast to reliability, which indicates whether a certain result will be reproduced in a similar survey, analysis of validity focuses upon whether or not "what" is supposed to be measured is being measured. TN 24 has shown that the results in TN 22 are very questionable in many respects. Part of the problem relates to definitions. The National Survey question about the number of times a person had gone fishing in the past year almost certainly resulted in wives who went along (but did not fish) replying that that they had, in fact, fished. Other validity problems relate to sample selections and survey methodology. There are biased estimates of numbers of participants and amount of participation but the magnitude of biases are not known so that the estimates which are being made are not the "exactly" correct estimates to give valid figures for participation rates, say, in hunting and fishing.

To give the reader some idea of the magnitude of the validity problems involved, predictions made of the amount of use of National Parks and National Historic Sites based on data in the 1972 National Survey proved to be more than twice the actual use of National Parks and National Historic Sites. One reason conjectured for this discrepancy is that by the time some people answered the question about use of particular National Parks and particular Historic Sites, they had forgotten they were supposed to be answering about their use during the past year, and, in fact, gave the total number of times they had ever used them (or a least the number of times in the past several years). Obviously, the results obtained cannot be used unless the nature of the bias resulting from incorrect answers can be fully documented and corrected for. However, a more obvious way of making a correction is by seeing that the answer to the right question is obtained. But this gets into broader issues of recall and the biases in recall which have not adequately been investigated as part of outdoor recreation

research (CORD Study or other). Millions have been spent on surveys but little on seeing that the results are valid (as opposed to reliable). Regardless, when one knows that there are serious questions about the validity of the results of the National Surveys there is little point in becoming overly sophisticated in defining the amount of statistical error involved in different observations.

Admitting the inaccuracy of many of the responses, one important point concerning TN 22 deserves mention. Even though the absolute numbers and percentage participation rates in different activities may be incorrect, it is possible that trends determined using these rates are still correct. The fact is that if various groups that were sampled incorrectly increased their participation in an activity at about the same rate, the percentage rate of increase of participation in the activity for the population will be estimated correctly even when "absolute" participation is estimated incorrectly. Even if the rather stringent assumption just stated for the percentage rates of increase to be exactly correct is not totally satisfied there is every chance that trend information presented in TN 22 is "more valid" than the absolute figures. Thus, there may be some merit in doing statistical error analyses to identify trends that are worth examining and those which are so dominated by statistical error that they cannot possible be accepted as indicating anything real.

Turning to TN 13, a proposal to do something that (1) is hypothetical and (2) contains a critique of what is proposed is difficult to comment on. It may never be possible to adequately define the parameters of models and estimate them with sufficient accuracy to do what is proposed in the note. In addition, the methodology suggested is, as indicated in the note, irrelevant where (a) there are major changes in the facilities or programs in an area or where policy changes regarding the use of facilities take place; (b) where innovation and technological change result in discontinuities in behaviour that cannot be modelled by the kind of model suggested and (c) where social upheaval and/or political change result in changes in (or constraints on) behaviour that cause discontinuities for which the model cannot possibly account. The probability that the necessary data will be available to develop a good model for any particular activity seems slim and even if a model can be developed the chance that the results predicted will not be invalidated by factor (a), (b) or (c) seems low.

To elaborate on the latter point, in preparing the model, a lot of assumptions are made about social continuity and economic stability, etc. With a world energy crisis and world food crisis on the horizon, models that depend on stability and continuity do not appear too likely to produce good results. From another perspective, examination of TN 6 permits one to get some idea of the sample size necessary so that survey results can be used in developing a good model. TN 20 has shown that there will be major problems in determining all the terms that should be included in a model

even if there were 100,000 independent interviews to work with and that determining interaction effects is no easy matter, although they must be considered if a model is to be valid. Furthermore TN 29 has shown some of mammoth problems involved in incorporating supply into the kind of model proposed. Yet supply must be considered if it changes over time.

Given these points, it is really only appropriate to consider that TN 13 gives a method that should be applied in conjunction with other less quantitative and/or less sophisticated projection approaches (say a Delphi). It may be pretentious to suggest that the method has anything to offer that is not as adequately handled by simple extrapolation of current trends. Still, it is intellectually appealing to suggest that we can correct for demographic change. However, unless adopting this complicated analysis procedure brings about a commensurate gain in the actual quality of the final estimates over simple procedures, the use of the procedure is not justified. So one must ask, when making estimates for five (or particularly 10 to 20) years in the future, whether common sense may be a better guide than a prima face sophisticated quantitative tool. The answer to such a question is not known and it is truly unfortunate that TN 13 or some other note did not make specific progress in answering this question for at least some circumstances.

THE UNITY IMPLICIT IN THE CORD STUDY ANALYSIS

J. Beaman and N.H. Do

CORD STUDY TECHNICAL NOTE 33

A UNIFIED FRAMEWORK FOR UNDERSTANDING CANADIAN OUTDOOR RECREATION DEMAND STUDY RESEARCH

PURPOSE

The purpose of this Note is to show the inherent unity that pervades the Canadian Outdoor Recreation Demand Study research work by showing how modelling behaviour has ultimately led to the development of theory and methods that aid one in appreciating both the nature and complexity of interrelationships between apparently differing research areas. There is also some concern with how modelling relates to the development and/or testing of allocation and allocation evaluation methodologies.

INTRODUCTION

Canadian Outdoor Recreation Demand Study research started out as a collection of relatively disjointed tasks. As one can see from the chapters in this volume, that origin modelling, destination modelling, the study of attractivity etc. were seen as relatively autonomous research areas. But, something rather revolutionary happened when it was recognized that the Cesario model (TN 4), to be interpreted in a behavioural way, should be generalized so that an alternative factor was introduced into Cesario's city emissiveness (see TN 11). This recognition began to bring together other disjointed observations to form an increasing picture of unity between different research projects. When studying attractivity in a comparative perspective (TN 9) it was found that to explain the difference between site specific attractivity factors and general attractivity factors for the use of a park based on people's behaviour, there was at least some evidence that a kind of destination alternative factor should be introduced. Pursuing loose ends in TN 1 resulted in developing TN 3 on alternative factors. In TN 3 both origin and destination alternative factors were eventually considered. It was also noted that in the 1971 proposal for an overnight use model (TN 30) an

alternative factor has been suggested which turned out to be essentially the one that was independently introduced into the generalization of Cesario's model to explain the "supply generates demand" and other effects (TN 11).

It is in the context just introduced that this paper was conceived. This paper was to include discussion of further generalization of the Cesario model (beyond TN 11) to a non-Cesario model proposed by Beaman and Leicester (1970). Firstly a destination alternative factor was to be introduced into the Cesario model. Then the Beaman and Leicester model was to be presented so substitutability-complementarity could be discussed. But, after some consideration of the deficiencies of the "twice generalize" Cesario model, it was concluded that a potential function argument compatible with the Cesario model be presented to bring in considerations which should play a role in modelling decision making.

Prior to presenting the specific generalizations finally arrived at and in the way of further introduction it is useful to consider what is already implicit in the Cesario model and what may constitute a generalization. For example, one may ask what happens when a particular park or facility is improved in some respect. Suppose that one observes that there is an increase in participation. This change in realized demand can be attributed to five more or less distinct sources according to Burton (References, Chapter IV):

1. Existing demand - growth in actual demand;
2. Latent demand - previously frustrated demand;
3. Induced demand - no desire until opportunity presented itself;
4. Diverted demand - diverted from a similar facility elsewhere;
5. Substituted demand - substituted from one type of facility/activity to another.

It is possible to suggest that "demand elements" one to four above are included to some extent within the Cesario model. Existing total demand is characterized in the Cesario formulation through the inherent emissiveness of a city modified by the "supply generates demand alternative factor" effect. Latent demand can be associated with time budget variables which are not presently identified on the Cesario model but which according to some Technical Notes can and should be considered (e.g. TN 8 and weekend, holiday and weekday use of destinations). With weekend and holiday and weekday models, new participants are implied, by the models to see an opportunity that is within their time, money or other constraints when a time budget change in holidays takes place. Previously they may have been "prevented" from participation but socio-economic changes, such as a move to a 4 day work week, mean that weekend-holiday models apply to 3/7 or more of the days in a period whereas a weekday model is only appropriate for 4/7 not

about 5/7 of the days. It is hard to say whether existing or latent demand or both relate to the proper consideration of "time bias" as introduced into the Cesario model in the appendix to TN 38. If people are willing to pay a money price, but not willing or able to pay the time-distance price for use of a site, is the increased use of a new site, that is closer but for which the users pay the equivalent of travel costs, a reflection of prior frustration of existing demand, or of something else?

Finally "Induced" and "Diverted" demand have clear interpretations. Induced demand should be identified with "the supply generated demand effect" since it is an effect that, by definition, relates increased participation to extra participation "induced" by increasing supply. For diverted demand, one need only recognize that attractivity changes alter people's choice of a destination. So understanding induced demand in relation to the Cesario model involves understanding the formula that indicates how total trips generated by an origin are prorated to destinations depending on their locations and attractivities. In commenting on how the various demands can be identified in the Cesario model one may have noticed an undesirable vagueness particularly regarding the first two types of demand. And, though there is some vagueness with respect to all of the first four types of demand it is somewhat distressing to notice that substituted demand is irrelevant in the Cesario model. At least this is the case until destination alternative factors are introduced in the next section of this paper. Then substitution at destinations is considered. In Section 3 of this paper the Cesario model is elaborated upon; so one also sees how substituted demand can be identified in an origin based substitution mechanism. Still all of the 5 "types of demand" referred to here are not very clearly defined and do not relate to one well-defined behaviour of people. Specifically in the paragraphs above, there was no emphasis on the types of user groups for which different Cesario models should be formulated. Demand will be affected differently by changes in supply for different types of users. Different models are necessary for different types of users, for different time budget considerations such as annual vacation, weekdays after work, weekends etc. Having such models is a critical matter in developing a better understanding of behaviour and particularly a better ability to predict behaviour.

The importance of considering user groups has been stressed elsewhere in this volume (see TN 7, 18, 30, 40, etc.). Having or using different models is only mentioned here because recognizing the need to develop different models, for flows for which attractivity or city emissiveness will differ, is as much a "generalization" of the Cesario model as showing the possible structure of emissiveness (as done in TN 11) or as introducing destination alternative effects and origin substitutability of activities as is done in this paper. It is however

because of (1) the need for using different models is well known and because of (2) the few theoretical insights following from anything that is or would be developed in this paper that no more is included on the matter. Still, this class of generalizations if pursued in considering time constraints, capacity of site constraints, influence of exogeneous variables such as weather (short term) or changes in roads (long term) leads to interesting and extremely complicated dynamic model formulations which as indicated in TN 40 must ultimately be developed if really good solutions to visitor flow and visitor generation by origin problems are to be found and used where now only questionable estimates are made.

GENERALIZATION 1: THE DESTINATION ALTERNATIVE FACTOR

Consider that a person is contemplating making a trip with certain activities in mind and that he starts to choose between destination areas at which he intends to carry out a main activity. Does he think in terms of attractivities that are park specific? Though this impression was left in the way TN 11 was written, and is implied in TN 4, this need not be the case. It is possible that factors other than characteristics of a particular park may influence the attractivities that a person perceives. These other factors may be such that when the Cesario model is used to estimate "park attractivities" the attractivities estimated may indicate not only something about the parks for which they are estimated but about activities that are available around them. One may recall that in TN 4 Cesario has stated that attractivity which is a property of a destination should not be affected by changing a destination's location. Implicit in this statement is "other things being equal". But the question is: WHAT other things being equal? One is left with the impression that the other things that are to be controlled for are the effect of distance and the effect of the different city emissivenesses on the use of a particular site. It is hard to read into Cesario's statements the notion that the attractivity of a park and its invariance with location involves invariance only holding when one is considering moving other parks along with a particular park to preserve a particular park's attractivity. Nevertheless, consider the problem that arises when a municipal authority, a provincial authority and a national authority along with private developers create a collection of complementary facilities all of which may be fairly similar. The user of any one facility may perceive the value of the opportunity that he has in terms of the value of the total resource base available to him including the possibility of using the federal campground if the provincial campground is full etc. If one were trying to understand the attractivity of each of these parks and one carried out a Cesario type analysis to estimate their attractivity (TN 4) and one only based their analysis on characteristics of specific sites they could

expect that they would not explain the attractivities of the particular sites well. If they recognized that an attractivity coefficient estimated using the Cesario model probably varies in relation to characteristics of a site and the composite collection of sites around it, and carried out their analyses with appropriate variables then they could expect better results.

The preceding paragraph may, however, seem rather obtuse. So now consider that the Cesario attractivity, A(d), for a park for a main activity x does depend on what is in a park, d. This component of attractivity may, for example be called the inherent attractiveness, IA(d), for the park for x as perceived by the certain type of user from a group g who is being considered because he goes to d for a certain type of visit (e.g. weekday use for a picnic: on use classification see e.g. TN 8 and TN 30). It is quite conceivable that the "Cesario attractivity", A(d), would be defined somewhat as follows:

(1) $A(d,x,g) = IA(d,x,g)\ S(a,x,g)\ EXT\ (x,g,A)$

WHERE $S(a,x,g) = IA(a,x,g) \exp(-P(x,g)D(d,a))/$
$IA(d,x,g))\exp(scx)$

WHERE the sum is over all available locations a for people to particpate in x.

P(x) is the effective distance on completion for people in A group g carrying out the particular activity

D(d,a) is the distance from d to available location a,

SCX is the substitutability-complementary exponent for activity x which indicates the positive or negative influence of similar activity being available at other like nearby facilities, and

EXT(x,g,A) is a function described immediately following which indicates the influence on A(d) of the availability of activities defined in the activity vector A, other than x when these other activities are available to the users of d outside of the destination d but relatively near to it.

No explicit form of the function EXT(x,g,A) is given here. One need only understand that this function indicates how the availability of activities which are not related to major trip purpose but which somewhat influence one's decision about where to go should be taken into account in assessing a park perceived or Cesario attractivity, A(d). Having some kind of amusement park facilities in the vicinity of a park may influence certain types of user to go to a destination d. Also it may influence othe types of users not to go there so that in the one case, (e.g - for

g=1), the value of EXT inflates A(d) and in the other (e.g. for g=2), depresses it. The critical point is: For some group of users, g, who are homogeneous in the way that they react to given circumstances when they are on a trip of a given type for a given purpose, it is reasonable to claim that their trip making behaviour can be influenced by what is near to a park. This may be because of the kinds of people that are activities available around the park attracted to that park. It is this and similar types of influences, which should be considered be embodied in the EXT function.

Before proceeding to comment on the other components of the right side of Equation 1, it seems important that the reader should note that the "Cesario attractivity" defined by A(d,x,g) is the attractivity that would be estimated if one used the Cesario model to estimate the parameters of a model for trip distribution flow for the people in g who, for example, went to the particular site for picnicking on a weekday during a given season. That is, if emissiveness "works" the way that it is postulated to, here or in one of the other related generalizations which are possible, the very fact that the function (Equation 1) can be written down shows that the Cesario "attractivity" need not be site specific but may be influenced by external factors and by "competing" or "complementary sites for the activity x." This is true because an A(d) defined by Equation 1 would be estimated correctly using the analysis of variance of trip flows as described in TN 4. IA(d) would not be estimated unless, as indicated later, d is an "isolated" destination. The difference alluded to is the difference between the Cheung and Cesario measures of attractivity which were studied in TN 9.

The reason that a main activity x is stressed is that the formulation presented above is not at all appropriate for camping when the dominant activity on a trip is something like visiting relatives, Ontario Place, Fortress Louisbourg, etc. In such cases the site at which one stays is possibly simply a location to gain access to the main activity. In such circumstances the model is certainly not appropriate for assessing destination area attractivity. The kind of situation just described is the circumstances associated with camping on Prince Edward Island during the summer.

Finally the remaining and the key idea being suggested in Equation 1 is that if there are a number of facilities at which an activity x can be carried out by a particular type of people who are being considered, the inherent attractivity of one site influences that of another. For people in group g with a particular trip purpose, one can picture sites in some sense emitting potentials so that if a person is thinking about a given location he perceives the potential for that given activity. (TN 5 and 17 present methods of measuring potential or pressure.) However, he does not really perceive it for, say d, he is always considering (1) the inherent attractiveness of a given site

(2) augmented by the inherent attractivenesses for alternative sites deflated by some function of distance. The function of distance can be considered to express how a person would react to the separation between the particular destination d which may be thought of at a given moment and its alternatives. These are reacted to as if one was at d. So, the "impedance of distance coefficient", P(x), is not the same impedance of distance coefficient that applies to travel by the particular type of people for their particular type of trip in terms of them actually going to destination d. An impedance coefficient of .05 which may apply with respect to travel to d is almost certainly larger than the P(x,g) of Equation 1. Once people are at the site they might see distance is offering a much greater impedance, say an impedance of .13 which shows a rather strong reluctance to travel more than a few miles.

The ideas suggested above may be more clear if one notes what Equation 1 implies under certain conditions. If for example all or some sites are "isolated" if that S(x,g) is close to 1.0 and so there are no external influences (so EXT(x,g,A) is also about 1.0) then using the Cesario model one estimates IA(d), site specific attractivities, for these sites. Now assume that there is an isolated site that is divided into four parts which are close to each other and assume that all parts serve the sme function nd that each part receives 1/4 of the visitors. The Cesario model will show that each part is 1/4 as attractive as the whole whereas if one may consider that SCX=-1:

A(d,x,g) = 1/4 IA(d,x,g)

IA(d,x,g) = 4 A(d,x,g)

So by the computation above, based on D(d,a)=0, between phe four parts, one may see that each part may still be considered as inherently attractive by its users as the total park.

From the preceding the reader may already have concluded that SCX=-1 is a critical value. For SCX=-1 a situation is defined where dividing a park does not affect the inherent attractivity of its "adjacent" parts. This actually makes behavioural sense within limits for certain types of parks for certain types of users on certin types of trips. There is no anomaly in the fact that a park with 3 campgrounds each with their own resource base are each inherently as attractive as the three considerdd as one destination with 3 parts. In other cases an SCX of -2 would be appropriate to show that for some users making a "wild river" or wilderness park into 4 equally attractive parks detract from each so that: IA(a,x,g)=2 A(d). One must recall that if 1/4 of the visitors that do come to a park go to each site, the equation just cited (based on SCX=-2) implies that each part of the park will only be seen to be inherently 1/2 as attractive as the whole and thus in total only 1/4 as many visitors will come if the park is divided.

As well, the opposite could occur with SCX less than -1. People could perceive the parts as complementary alternative destinations and increase their use of the general destination area by going to the "different" parks for variety. In reality there need be no variety. It is interesting to conjecture on the use one mountain park would receive if Banff, Jasper, Yoho and Kootenay were combined.

The preceding paragraph provides good examples on which to comment on why there is a concern here with both complementary and substitutability. When the perceived and the inherent attractivity of a site is decreased, because of "competition" with or at least the existence of other sites offering one the same experience, it seems fair to say that the sites are substitutes for each other. But, if having several parks rather than one large one or having several destinations near each other where one can go if one area is full results in an increase in total use over what the destination area as a single entity would receive, then one can refer to the sites as complementary. To refer to these parks as substitutes would at least be a poor or misleading use of language. Obviously in terms of the examples in the preceding paragraph SCX greater than minus one defines a condition of substitutability whereas if SCX is less than minus one there is complementarity. Nothing more is stated now because the relation is commented on again later in discussing analagous origin based substitutability-complementary conditions.

One could pursue the intricacies of estimating the IA(d,x,g) values along with the other unknowns in Equation 1. However, then the kinds of problems discussed in TN 11 would have to be pursued since in the original estimation exercise if "Cesario attractivities" were estimated for 50 sites, only 49 independent estimates of attractivity would be available on which to estimate 50 inherent attractiveness values, an impedance of distance value, a substitutability-complementarity exponent and some parameters of a function EXT(x,g,A). Obviously constraints have to be introduced or parametric forms of the inherent attractiveness function must be estimated so that model parameters can be found. If one pursued the alternatives of defining the IA(d,x,g) in terms of site characteristics then they may note their estimation procedure would be the logical extension of the AID analysis of attractivity pursued by Cesario in TN 4.

GENERALIZATION 2: "SUBSTITUTABILITY AND THE DECISION TO PRIMARILY DO ACTIVITY "a" AT A MAIN-DESTINATION ON A "FAIRLY" SINGLE PURPOSE TRIP

For this generalization it was planned originally to present a formulation by Beaman and Leicester (see Reference Chapter VI) which was not developed with the Cesario model in mind. However, it was then recognized that the important ideas of concern could be elucidated by presenting a model for which "phase I" emissiveness and attractiveness values

could be estimated as Cesario has illustrated (TN 4). So, rather than introducing new modelling concerns it was decided to further clarify what Cesario's parameters could mean when use of alternative facilities is allowed.

To present this final generalization of the Cesario model it is convenient to introduce it in stages starting with very simple assumptions and then introducing other matters which must be pursued if overly simplistic assumptions about what emissiveness means are to be relaxed. So initially accept that there is the kind of aggregate as indicated in the last section might be determined with the methods described in TN 10 or a group "g" as described in TN 19, the behaviour of which is being considered. Accepting that these people are assumed to be "homogeneous" in terms of their interest in the only main-destination activity, x, that is available meaning that all people in the aggregate have the same probability of participating in the given activity in similar circumstances, (at the same location, on the same day of the week, under the same time constraints, etc.).

Now visualize that at a point in time any one of these people has a choice of going to a facility to participate in x or not going and that this decision is made in terms of "the potential" that the person perceives for participating in activity x. In the context of TN 5 one may consider that at every point in space at which this person might be, there are potentials to participate at different facilities which he perceives and that these facility specific potentials are defined by:

(2) P(o,d,x,g)=(A(d,x,g)exp(-r(x,g) D(o,d))

WHERE A(d,x,g), r(x,g) and D(o,d) are as defined in TN 11 except that activity and type of person subscripts have been added.

Also, consider that there is an impact on total participation which depends on the best opportunity in a way defined by a weighted sum of potentials, an alternative factor, defined over each of the individual facilities at which a person might participate.

(3) Total Participation = M(o,x,g)AIU(o,x,g)

TP(o,x,g)=((P(o,d,x,g)/PP(o,d,x,g))**SE)**SM

PP(o,x,g)POP(o,x,g)CG(o,x,g)

WHERE again the terms are as defined in TN 11

In specifying the preceeding, it must be accepted that a person (party or some other group) may be considered to have some rule according to which it is decided which of the alternative facilities available is to be visited to participate in x. The rule need not be explicitly defined

but still trips to the different facilities may be made in proportion with different potentials, in proportion to the potentials for participation that are "perceived" for each of the alternative facilities (Equation 2). Then if expected total number of trips in a time period are defined in terms of reaction to "total" supply, as defined in Equation (3), the amount of use that will be made of a site can reasonably be taken to be:

$$V(o,d)=P(o,d,x,g)TP(o,x,g) \tag{3A}$$

An alternative rule for distributing use to sites is that people are economically rational in terms of potentials. In this case it would be assumed that one always goes to the facility with the highest potential. This formulation is not compatible with the Cesario model because zero flows from an origin to all but one destination by people in a group g implies zero attractivity for the unused sites. But if some are used from other origins, then for these origins the first site has zero attractivity. These different "manifest" attractivities contradict the Cesario formulation which is according to "generalization 1" of this paper, at least based on the assumption that from all orgins, a destination area's attractivity is the same for comparable users.

Regardless, at this point one should note that the considerations introduced in the last few paragraphs are very easily related to the matter raised in TN 29: How does a person relate to the facilities that he knows are around him and which in some sense he may perceive as offering him opportunities to participate in an activity. In terms of Equations 1 to 3 an answer is offered. In a simple conceptualization one visualizes a person in some location "impinged on" by potential surfaces. For now, the person is not concerned about what activity to participate in but only where to go given the potentials for x which he perceives. He may also be concerned about how often to go, whether to go under given weather conditions etc. but the decision processes involved in reacting to these factors are not pursued here (the equations here are really for a "seasonal average" rather than more detailed (as based on TN 8 methodology).

As indicated in TN 11 the kind of socio-economic variables considered in TN 12 and in other Technical Notes may be considered to define a general level of participation to expect for a person with given characteristics. Or, as pointed out in TN 10, 13, 32 and 37 it might be better to identify a person with an aggregate of people based on his activity package. But, the matter of importance now, is to consider that a person is never only exposed to the various opportunities to participate in a single activity. It is reasonable to ask how one's exposure to multiple opportunities, A, affects his choice to participate in a given activity, x. In the last section it has already been indicated that alternatives for the major activity or to the

major activity that occur around a destination can be considered to affect "inherent" site attractivity, IA(d). For that reason the perceived or manifest attractivity, A(d), was used in the preceeding equations to show the direct influence on judgements of percieved attractivity. The equations could be written with IA ( )'s substituted for A( )'s but the authors believe this to be inconsistent with behaviour and with the TN 11 formulation in which the estimated A( )'s were used in deriving explicit expressions for origin alternative factors.

With the point about the importance of considering A(d) in mind, now accept the obvious that a person perceives the potential to participate in a number of activities. How do these different potentials operate in affecting the person's decision to participate in a certain activity. For people in the same aggregate, group g, one may visualize the decision to participate in a activity as based on the "merit" seen to be associated with each activity in a collection of different activities based on where each person is with respect to various destinations.

For example, it is plausible to suggest that an individual chooses among activities so that the proportion of all trips which are made to participate in x can be expressed for a person in "g" who lives at "o" as follows:

(4) PROP(x,g,o) = ws(x,g)PI C'(x)/ @E ws(a,g)PI C'(a)

WHERE

1) the sum is over all a in the activity vector A.
2) PI is the row vector of potentials P(o,d,x,g)'s defined by Equation 2 for all a in A.
3) ws (x,g) is the weight that people assign to the "desirability coefficient of activity x" defined by PI C'(x) in measuring it against other such coefficients.
4) C(x) is a vector of complementarity weights c(x,y,g) which indicate how much having unit potential for y available "complements" negatively or positively participation in x(c(x,y,g) is by definition 1).

The stochastic or proportional distribution interpretation suggested above might be adopted to account for the fact that from day to day, activities shift. Shifts, may infact be a reflection of the utility of changes in activity patterns. Basically the hypothesis introduced is that certain weighting vectors are appropriate at any point in time to assess the merits that are associated with a particular activity for a person in a given aggregate. Specifically, one may note that Equation 4 is defined in such a way that if there is only one activity available to an origin:

(5)
$$\mathrm{PROP}(x,g,o) = \frac{ws(x,g)P(o,d,x,g)c(x,y,g)}{ws(x,g)P(o,d,x,g)c(x,y,g)} = 1.0$$

If there are n activities that do not interrelate (e.g $c(x,y,g)= 0$ for $(x \neq y)$ and which have the same potential then one can easily derive:

(6) PROP(x,g,o)=ws(x,g)P(o,d,x,g)/ ∂E ws(a,g)P(o,d,x,g)

WHERE the sum is over a.

Equation (6) implies that a person in g distributes his activity to the various possibilities in proportion to their substitutability weighted potentials. This of course involves the implicit assumption that (1) the activities are equally substitutable in a "time slot" where participation in any activity can occur. This involves the activities being equally substitutable under different weather conditions etc. or it means that (2) in the aggregate participation frequencies average out so that Equation (6) can be used to explain what happens in the long run. It can show average sustitutability based on the different size "time slots" being available, under different weather conditions etc.
In the context of the ideas presented in the last paragraph one can see that PROP(x,g,o) is a ratio which can be considered to reduce the inherent emissiveness, G(o), of a city for a given activity where alternatives are available. So, in the context of the generalization of the Cesario model introduced in TN 11, one is now saying that at least part of the C(1,0) and C(2,0) constant where said to relate to "city uniqueness" in TN 11 may not really reflect city uniqueness. In fact if people in group g in city 1 were compared with similiar people in g with city 2 it is possible that, say in terms of main-destination day-use of parks, C(1,1).NE.C(2,1) or C(1,2).NE.C(2,2) merely indicates that these constants (defined in TN 11 only) equal the appropriate PROP(x,g,o) for the two origins and PROP(x,g,1).NE.PROP(x,g,2). In other words, it is reasonable to suggest that Equations (3B) and (3C) of TN 11 should be rewritten to show if it is to be clear that the C( )'s do not "include" substitutability factors but only "truly" reflect city differences other than supply differences. One might for given x and g write:

(7) C(1,2,x)g)= PROP(x,g,1)CUNIQ(1,2,x,g)

(8) C(2,2,x,9)= PROP(x,g,1)CUNIQ(1,2,x,g)

WHERE now it is considered that the CUNIQ( )'s constants really reflect city uniqueness.

Incidentally, the fact that Equations (7) and (8) are simply a new way of writing emissivenesses which can be estimated as discussed in TN 11 is proof that origin substitutability-complementarity may influence the values of E( )'s estimated using Cesario's "phase I" estimation. Given that this is true it also follows that if truly good models of behaviour are to be built, empirical work on

assessing or measuring substitutability should proceed. However, given that results presented in TN 29 show how difficult and potentially costly it is to assess response to just one type of supply, it must be recognized that work on substitutability-complementarity should be carefully designed and proceed slowly from one success to another rather than being undertaken in a grand experiment. Any grand project will have little chance of success given the problems to be solved in "origin emissiveness" studies; and their relation to visitor flow analysis problems to be solved; and the relation of these problems to other problems as described in the next section of this paper.

Before turning to the next section some practical insights regarding "city uniqueness" and complementarity-substitutability may make the preceeding formulation more understandable. Firstly regarding substitution, one may note that near some cities, Ottawa, for example, there are abundant opportunities for cottaging where in other locations this is not the case. In some provinces there are abundant crown lands that can be used for camping, hunting or fishing with few restrictions. In others one or all these activities are rigidly controlled. Now both cottaging (not in a park) and use of non-park crown land for camping "compete" with using parks for anything. When people allocate their finite time and money to participating in activities they make allowance for substitutes. So here one may note that formulae presented earlier should and do allow the effect of having such substitutes available to be accounted for in estimating particiption in activities. Complementarity is another matter as Beaman and Leicester (1970) have stressed and it has often not been dealt with adequately by those analysing behaviour or proposing analysis strategies (see TN 37 and comments in TN 10 and TN 32). The opportunity to go shopping in Alma townsite outside Fundy National Park or to drive for pleasure to the horse races and shop and eat in various places in PEI complement a visit to PEI National Park for a certain type of visitor but in this paper such influences should be related to Generalization 1 and destination alternative factors affecting a destination's inherent attractiveness. Rather, having a high potential at an origin to visit historic sites may not really relate to high emissiveness to picnic grounds because the attractiveness of particular picnic grounds is enhanced by historic sites being near them. People may picnic when or as long as the weather is good and then "retreat" to a complementary activity when the weather is bad. Another case is where a person would not go to a park unless the trip offered the complementary experience of a drive for pleasure. The general potential for driving for pleasure in going to parks from Ottawa may "enhance" the "raw" potential for visiting parks whereas traffic problems in Toronto or lack of scenery in Saskatchewan near Regina may reduce "raw" potential for park visits ($c(x,y,g)$'s can be negative or positive).

Finally, to focus again on an important concern,

implicit in the idea that the person who is being considered is a certain type of person (the issue taken up in TN 10, 32, 37 and to some degree in notes like TN 8, 14, 37, 30) is the following. If a person is an outdoor orientated person with an orientation to exurban rather than urban outdoor activities then at a given point in time, let us say after work on a given day with good weather the person may have a greater tendency than an athletic activities oriented person to rush outside the city to some area for a brief hike. The other person alluded to might go to a nearby tennis court and play tennis or to go to an indoor area and play squash. But returning to the main concern if both persons referred to are confronted with the same geographic configuration of facilities at which to carry a number of different activities (which may also include social and cultural activities) and have the same time constraints and weather conditions each may be viewed as perceiving different attractivities for different facilities and thus as assigning different weights to the merits of carrying certain activities.

Now, it would be possible to turn to estimation concerns in relation to Generalization II, but as was the case with Generalization I little is said. Certainly in 1976 from a modelling perspective it is not feasible to think that information for calibrating the kind of generalized model described here is available. Some detail must be sacrificed. So, one is in all practical studies dealing with a modelling approach that yields an "aggregate" solution for "an average individual" in particular circumstance. Such models can (or really must) certainly be adequate for most purposes for now. One for now must view the generalized model as a conceptual guide in research planning. It can be used in deciding where and how, simple models can be used in certain circumstances. However based on results presented in TN 11 one must accept that "Phase I" attractivity and emissiveness estimates based on the Cesario model are influenced by factors that are highly significant but which have not been explained by origin or destination characteristics. Until more is learned, even our best models cannot be expected to yield really accurate origin destination flow estimates. Possibly it is time to use the TN 19 methods for finding structural problems in models so as to derive better models as soon as possible, rather than continuing expenditures on poor ones without even establishing how poor they are.

DISCUSSION: THE UNITY IN THE CORD STUDY

Summary Overview

As suggested earlier in this paper when the importance of understanding what the Cesario emissiveness coefficient meant was realized, a path for discovering the unity in CORD

Study research was opened. As work on TN 11 progressed the following possible elements of Cesario's emissiveness for an area were recognized in the formulation developed:

1. Its dependence on the general array of facilities of a given type available to a person in the area who wants to make a given kind of trip –
   a) depends on how total trips relate to the configuration of supply for an area and
   b) depends on how total participation at all facilities is prorated to specific facilities;

2. Its dependence on the "aggregate" socio-economic characteristics of people of the area;

3. Its dependence on the unique character of the area being considered; its dependence on either a special geographic character or a special socio-cultural character.

The study of Cesario's attractivity measures for parks in an attempt to understand what it meant led to other insights already alluded to in the article:

4. Cesario's park attractiveness need not be considered a pure measure of how attractive a park is but for certain types of trips for a park may depend on what is around the park –
   a) in terms of similar competing facilities and
   b) in terms of different competing or "complementary" facilities;

which may either add to, or detract from the attractiveness of the park being considered depending on what users in a given group there want.

Finally, the "origin based" substitutability considerations introduced show "how", in the context of the formulation developed in TN 11:

5. The inherent emissiveness of a city, which really applies to participation in an activity where there are no other activities to consider, can be properly dealt with if one introduces an effect on inherent emissiveness for an activity "a" of the opportunity to participate in other activities. It can be properly dealt with if one introduces an origin based substituability-complementarity factor.

It has been repeated numerous times in commenting on the general logic behind the points received above that one

must be concerned with (1) attractiveness to whom for what purpose, (2) substitutes for what type of person under what type of time budget, weather etc. constraints. If one cannot identify types of people, types of activities, tradeoffs between activities for groups for which they are meaningful, then there is no point in "identifying" them for behaviourally meaningless aggregates unless this can be justified for developing an approximate model. The exception is if a model is built for policy purposes then any structure can be specified. It is perfectly valid to investigate how people would behave if .... or to investigage the ultimate consequences of encouraging behaviour that conforms to a given model. Regardless, the point here is that (1) to (5) above, in this "summary overview", should be thought of in terms of the behaviour of a particular person or a particular type of people, if the statements are to have the specific behavioural implications which they appear to have.

UNITY AND "ALTERNATIVE FACTOR MEASUREMENT"

However, enough has been said in general overview. It may not be clear from the terse notes that most of the interrelations indicated in Figure 1 can be understood in terms of the points raised about the Cesario model. For example,

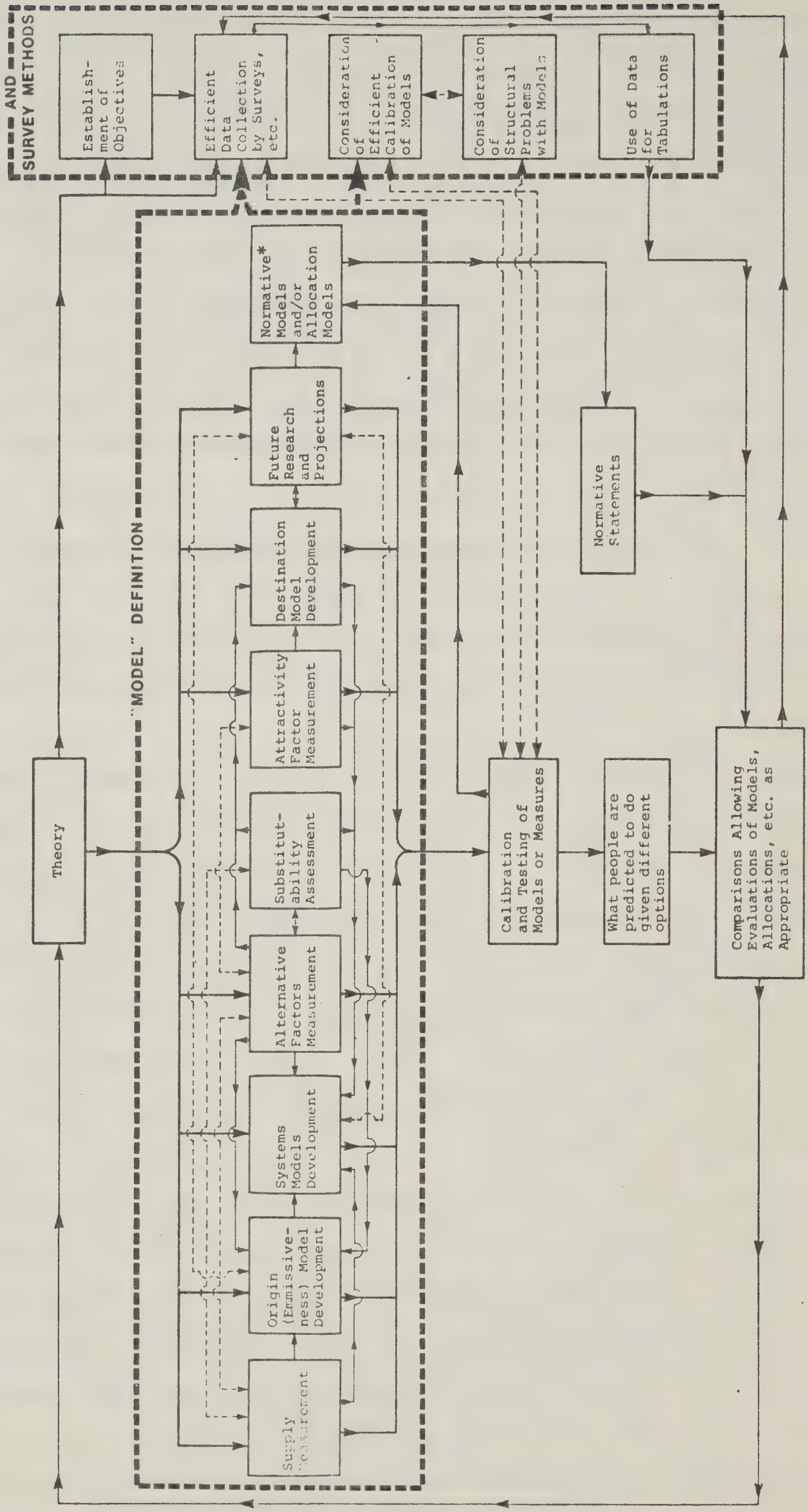
to start to see in detail why the connections between research concerns depicted do occur consider firstly how alternatives factors, their definition and measurement, relates to other research areas shown in Figure 1. Alternative factors in TN 3 have been the focus of theory development and "considerations of structural problems with models" work because of the way they were used in TN 1 and their proposed use in TN 30. In TN 1 questions were raised about the significance of the alternative factor but of more importance regarding "Calibration and Testing of Models" and analysis and survey methodology is the fact that questions raised about the CORD Study Park User Survey and the possibility of calibrating the models proposed in TN 30 resulted in the cancellation of empirical work on the "Overnight-Use Model".

In TN 1 and later in TN 11 one has clear indication of the importance of alternative factors in "Futures Research and Projections", obviously as new facilities are created and some old facilities are phased out, models must change to reflect the supply configuration with which people are confronted. Alternative type factors are obviously key model elements for reflecting this change. This is because they reflect very directly that when one is formulating destination models they should really (or are really) involved in "Systems Models Development".

A number of other observations point up how alternative factors keep being noted as important with respect to other research areas. An origin alternative factor appeared when

FIGURE 1

THE UNITY IMPLICIT IN THE CORD STUDY ANALYSIS



the generalized Cesario model was formulated in TN 11. Also in this paper it has been shown that destination alternative factors should probably be considered if one is to truly understand what Cesario's estimated attractivities mean. Of more importance is that in TN 11 a link between Cesario's emissiveness values and the parameters of an origin model was specified. This is because the combination of "supply generates demand" effects of a prorating of use effect, and of an alternative type factor (of TN 11) can be seen to relate to the "effect of supply" or supply measurement problem exposed in TN 29.

ORIGIN (EMISSIVENESS) MODEL DEVELOPMENT

Though it is not worthwhile to deal with every heading in Figure 1 and discuss all possible relationships between headings, a second example may convince the reader of the degree to which "Model Definition" research should be integrated. Material in TN 11 on origin emissiveness has pointed up that alternatives to a given facility at which one can participate in an activity may influence origin emissiveness. Actually TN 29 can be viewed as another paper on how alternative supply and its measurement must be considered in measuring origin emissiveness. In TN 29 important statistical considerations, important analysis and survey methods concerning efficient data collection, model calibration and survey design are raised.

TN 35, the appendix to this volume, and the review for Chapter 7 concern statistical issues of importance in emissiveness analysis. Other articles deal with more behaviourally oriented methodological problems with origin models. They raise difficulties with the method of measuring origin emissiveness (TN 6, 13, and 20). Still, TN 13 relates the TN 12 work on applying origin models to "Futures Research and Projections" while TN 6 answers questions about the accuracy of estimates of origin emissiveness using the methods described in TN 12 and TN 13.

TN 10, TN 13, TN 32, TN 37 and some chapter review material raise important THEORY, "Calibration and Testing of Models of Measurement" and Normative considerations in relation to origin emissiveness. Such concerns as the equity of distribution of the emissiveness to different groups in the population relates to theory issues in TN 32, methodological points in TN 10, TN 13, and TN 37. Also they issue of how facility complementarity-substitutability affect origin emissiveness is broached.

OTHER MATTERS

The preceding has concentrated on origin models, destination models attractivity, alternative factors, the major effect of supply. One may ask is there any unity in the CORD study with respect to some of the other topics that

were dealt with in technical notes. In Figure 1, it is possible to delineate three lines of consideration that do not have much to do specifically with the kind of modelling already mentioned: allocation modelling; design of data collection; and theory development and theory testing. The unity of the study with respect to these areas is fairly obvious. What one has seen in this article is in fact how the results of one empirical research project are interrelated with other research projects leading to theory development. In particular, with respect to research design, it should be noted that TN 6 with respect to origin models, TN 19 with respect to destination models, have presented formulas which have utility in determining what sample sizes are necessary if models are to be redeveloped that meet certain accuracy criteria. In a similar way one can see the explicit statements in TN 20 on how to improve origin models, and in TN 35 on how to improve destination models (actually, comments on improving destination models occur in a large number of TN including 3, 7, 40.)

And now starting from the perspective introduced in a number of places in this volume, it is consistent to maintain that allocation evaluation models need not be consistent with behaviour. Pressures computed in Technical Notes such as in TN 17 need in no way reflect real pressures felt by people. Rather, what the method may be used to do, is to produce a measure of people's relationships to resources. If they don't feel deprived at all then it may still be the case that a policy decision will mean that actions on their "needs" will be taken. Similarly, the question as to whether the potential surfaces generated by the methods described in TN 5 really reflect pressures that could be documented by a study is not necessarily considered to be a pointed issue in this volume. Unity in theory with theory or with empirical work is obviously of concern to some of the authors, as seen in TN 5.

SPECIAL RELATIONSHIPS THAT DESERVE MENTION

The preceding has been primarily about model definition, theory and analysis and survey methodology. Still there has been some mention of normative concerns and allocation. It is the perspective, introduced in a number of places in this volume, that it is consistent to maintain that allocation evaluation models need not be consistent with behaviour which results in the loose link between chapter 8 Technical Notes and other Notes. This is because one believes that the Technical Notes in these chapters either (1) allow one to see many problems to be solved to improve allocation and evaluation models based on behaviour or (2) forces one to recognize that researchers must do much work with policy makers, managers and planners to define objectives, to define goal-achievement standards and to define acceptable ways of assessing what should be in terms of policy and political perspectives. Specifically some

researchers believe that the "pressures" computed in Technical Notes such as in TN 5 and 17 should reflect real pressures felt by people. Some believe consumer surplus as measured in TN 31 and 38 is "real" measure comparable with real dollars and produces a measure of people's relationships to resources. If people don't feel deprived or are not willing to pay the price consumer surplus suggests policy action will still be taken because the models are accepted and used.

Similar concerns with the relation of models to behaviour modelling is also clearly of major concern in TN 23, 25 and 26.

In TN 41 there is a dichotomy. This is expressed in the question: Was the kind of research done a good use of resources at the time or should the policy issues have been clarified to indicate if any empirical research should even be done. Similarly TN 40 raises questions about the relevance of the economic impact study approach discussed in TN 39 and elaborated on in this other note (TN 40). Can policy be empirically derived is the critical question that underlies different ways of viewing the notes in Chapter 8 in relation to other notes. A methodological question that raises issues about modelling and policy is whether models derived on data when one policy is in effect are even relevant in predicting behaviour under a quite different policy. The pessimist will see behaviour based models as primarily relevant to planning based on the status quo.

CONCLUSION

This article has documented the progress of the Canadian Outdoor Recreation Demands Study and a unity in it, at least in terms of progressing toward a goal of being able to predict people's behaviour and to relate it to policy oriented models. However, it is fair to say that the interrelationships that should be considered in predicting recreation behaviour are frighteningly complex. In this regard the model implicit in the "generalized framework" for modelling which has been described is not a model which is going to be calibrated in the foreseeable future or even totally defined in the foreseeable future. It is only a model which serves as a guide to thinking.

From a broad perspective it must be admitted that the rather substantial results reviewed in this chapter when considered in perspective do not really show that much progress has been made in modelling or understanding people's participation in outdoor activities. This chapter has concentrated on models which are good for "main-destination" "fairly single purpose trips". What part of recreation trips fall into this category. What planning or management needs for information can be met by such models. Then there is the effect of substitution, there are problems of defining user types for which various models are useful etc. etc. And, always, there is the lingering doubt:

Where the balance should be between using "quick and dirty" methods with "due consideration" of what can be achieved by advertising that is sometimes needed and justified in dealing with the planning and management problems on which researchers work but which will never develop if each or most research projects do not contribute to a growing knowledge.

But even if research methods do develop, possibly the most important concern must be with how research on behaviour should relate to policy evaluation and the development of policy. This is a problem area as indicated in Chapter 8 and it is barely explored in this paper or in this volume. The critical consideration is raised in Volume I and that is that researchers must not be technicians but interact with planners and managers to develop an understanding of policies and policy problems so that they may make their proper contribution of indicating where and how research can be used and discourage its misuse.

CORD STUDY RESEARCH - FINDINGS AND CONCLUSIONS: AN INTREPERTATION

J. Beaman, E. Avedon, T. Stewart

Some readers, may have expected the final CORD Study report to indicate national and provincial recreation resource requirements for the next decade or so. An objective such as this could never have been reached for a multiplicity of reasons. In general, these reasons fall into three major groups: administrative, epistemological, and data collection. The three final volumes of The CORD Study attempt to document these reasons.

Volume I in this series indicates some of the problems inherent in The Study within an administrative context. The Volume describes the massiveness of the undertaking, and management problems which both helped and hindered the conduct of The Study. Volume I also examines the many Study issues related to the interaction between policy, planning, and research.

Volume III describes the empirical issues confronted in The CORD Study. An attempt has been made in Volume III to illustrate the many problems inherent in collecting and processing national data. Issues regarding sample design, questionnaire construction, data collection, computer processing, and the like, are described in detail, in order to offer readers the opportunity to learn from the mistakes made during conduct of The CORD Study.

Volume II, in contrast, is indeed "the heart" of The CORD Study. Very early in the conduct of The Study it was recognized that numerous epistemological issues had to be solved before much "true" CORD Study analysis could take place. The "deeper" CORD Study researchers became involved with epistemological issues, the more they found themselves on the periphery of demand analysis methodology. They found that they were "forced" to go beyond what was known in order to attempt to achieve CORD Study objectives.

Thus, although the original study design did not envision methodological research as the dominant focus of The CORD Study, the sheer massiveness of this latter undertaking (of necessity) overshadowed all other aspects. As a consequence, CORD Study research (in spite of a range of severe limitations) has made a major technical contribution, not only to the nation and to the provinces, but to recreation research in general. Volume II offers readers a knowledge of what CORD Study researchers have learned within an epistemological context.

This chapter then, is an attempt to summarize epistemological contributions of The CORD Study, (those

which seemed particularly important in the research context of the authors as of 1976) and indicate some of the questions that are still to be answered through future research efforts.

DESTINATION MODELLING

TN 1 established that a systems model could be defined to explain the day-use of parks. The model is a systems model because of the manner in which the alternative factor is defined. Since almost no variance was associated with the alternative factor or with the attractivity factor, these factors had no practical importance. (However, it must be noted that the regression analysis carried out was not completely valid, and thus the variance explained by the entire systems model was spuriously high.) This latter issue is explained in some detail in TN 19 and 35. Nevertheless, despite the structural problems in the model, some progress in this aspect of study has been made. The model used for the analysis presented in TN 7 relied upon the model derived in TN 1; consequently, there is nothing that can be learned about the empirical validity of the model presented in TN 7. A lack of availability of data and better models prompted the approach presented in TN 7 and also provides insight into the research needs alluded to in TN 30 and 40.

The potential for formulating a good enroute-overnight park-use model was illustrated in TN 18. A concern for the accuracy of potential estimates is illustrated by the strategy of developing a model for one set of parks and then using the model to predict the use of another set of parks. However, it is an open question as to whether additional effort should have been made to examine alternative structures for the model. Availability of adequate data was a major problem in developing the model in the first place, and this prompted the formulation and testing of only one model structure. TN 18 perhaps serves as an object lesson for researchers who try to do more research than is feasible with the data they have at hand.

Basic parameters characterizing park-use (as indicated in TN 4) can be derived with a minimum of assumptions about how characteristics of origins of park users influence the emissiveness of the origin, and about how attractiveness of parks should be defined. Fortunately, the original research plan for TN 4 was altered, since the analysis proposed was not feasible with the type of data under consideration. In this instance, reliable alternative data were obtained; however, certain key data on visitor types, length of stay, weekend or weekday use, and the like, were not available, indicating once again the need to carefully plan data collection. The results obtained should not be construed as an indication that a "good" model had been developed. (See TN 35 and 11.) Much of what one might think can be learned about participation at various destinations is not to be found in the attractiveness or emissiveness coefficients

computed. Comments regarding structural shortcomings in this model are presented in TN 11 and 33. These comments also foreshadow the difficulties inherent in generalizing a model.

In order that the reader not be misled about application of TN 4 results, TN 11 attempts to make clear that emmisiveness values should not be expected to be a "fundamental" parameter of a city. These parameters almost certainly depend upon the aggregate demographic characteristics of the city's population, and to a greater degree, reflect a city's relationship to its supply of resources for recreation. TN 9, as well as TN 33 indicate that there is good reason to believe that attractiveness measures are deceptive, in that they are not simply a measure of the attractiveness of a particuar park. Seemingly, other parks around a given park influence the attractivity of the park in question. Attractiveness and emissiveness parameters cannot be computed for the use of a new park using TN 4 methods.[1] A model for which parameters can be estimated is presented in TN 11 and it is predicated upon reasonably plausible behavioural assumptions. As a consequence, even though both the TN 4 models are structurally compatible, the model presented in TN 11 can theoretically result in more than parameter estimates. This is because the theoretical formulation presented in TN 11 indicates how park-use varies with the supply for a given model. Extending this approach (as in TN 33) can permit the development of more structurally sound models. Unfortunately, although several variations of the model could have been formulated, this did not occur.

A useful perspective for modelling behaviour is presented in TN 8. Researchers often employ one model to explain park visits on both weekdays and weekends. There is no reason to believe that weekday park-use should be "explained" by the same model which is used to "explain" weekend behaviour. This is also true for different types of park-users. TN 8 offers suggestions for the kinds of functions to be derived for these different types. (TN 40 comments on this latter point.) Confirmation of parameter estimates obtained using the "ordinary least-squares regression approach" is discussed in TN 19. This approach is not statistically efficient. By using the regression approach proposed in TN 19, better estimates of parameters can usually be obtained with only half the data that are required for the former approach.

Many of the insights gained from the analysis presented in TN 35, are similar to those reported in TN 19. The

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1. If a new park will not be close to other park sites, and will have little influence on total park use by residents of various cities, then it may be assumed that no city's emissiveness will be substantially influenced by the inclusion of the new site in the existing park system.

simulation approach pursued in TN 35 provides another way of testing structural adequacy of models - a method which some researchers prefer over the method discussed in TN 19. The important point however in TN 35, is that accuracy criteria appropriate to the problem being considered must be developed in order to derive "good" models. Overall X^2 and individual residual X^2 are extremely important in assessing model structural adequacy. The need to use X^2 values to measure the validity of a model must be considered as a major, important and unexpected result of the derivation of a distribution of observed flows. The use of both GLS regression and "residual testing of model adequacy" is a very significant advance in modelling. Residuals for individuals mean little in origin modelling because of the large variance between observations, and the expected or probable behaviour is estimated. In origin-destination flow modelling a given flow may be accurate to plus or minus 1% if the flow is large.

The use of arbitary assumptions to describe (apriori) how people respond to alternative park sites is discussed in TN 3. Such assumptions may lead to statements about behaviour which are illogical. TN 3 (originally prepared to further theoretical development of the model presented in TN 1) makes clear the importance of alternative factors in assessing how people respond to the supply of parks. It relates nicely to a variety of behavioural considerations which must be considered to construct "good" behavioural models which are discussed in TN 33. Still, one should note that elaborate models that tap aspects of behaviour, such as substituting one activity for another are not empirically validated at this time.

In a number of the CORD Study efforts, data problems caused cancellation of planned research. TN 30 reports one of these cancelled efforts. As a consequence of formulating a work plan, it became apparent that there was little likelihood that the study objectives could be achieved. TN 30 is an example of good research practice, in that a research design should be developed to the point at which an assessment of potential success can be made. If this assessment reveals that study objectives are unachieveable, then research should be terminated. In addition to this "lesson", TN 30 also serves another function in that it brought together a number of inventive proposals for model development. These proposals have implications and interesting parallels with the formulations presented in TN 11. The proposals presented in TN 11 were independent of TN 30 - they were based on considerations raised by research questions reported in TN 4.

Thus, a number of substantive methodological research projects in the CORD Study have been concerned with destination modelling. Many of these indicate that much of the current work on destination modelling results in models which do not explain data as one might expect. One major reason is the fact that often these models are developed from unreliable data. Another major factor is the lack of

adequate consideration of the disagregation of user groups into groups for which meaningful models can be developed. A serious question which must also be considered is that when use estimates are made for a given point in time, how can these estimates be extrapolated for future policy and planning. In reality, considering the various methodological problems and the special difficulties associated with the use of destination models in planning and policy analysis, it is apparent that progress made in this area is quite minimal.

ATTRACTIVITY ANALYSIS

How people respond psychologically to a landscape obviously does not have a simple relationship to estimating the number of visits that people will make to a particular park. The matter of park attractivity, and wild river site attractivity, have been examined as separate issues.

A consumer preference approach can be used to derive park attractiveness measures (TN 2.) However, there are a number of methodological problems associated with this approach as a consequence of limited and poor data. From a planning perspective, the ordinal attractivity scale has only limited merit in making use estimates for parks. TN 9 examines the question of what really is measured by different types of attractiveness measures, and which of three types under consideration, are compatible. One finding indicates that users respond not only to a park, but also to what is around it. TN 28 is concerned with another matter, namely, testing the "goodness" of attractiveness measures. There is controversy about this Note however, (see Chapter III, Review) because it was indicated that when two different measures, based upon different assumptions, are put into the same model, comparable explantions should not be expected.

Turning to site quality, the assessment of the quality of a site on a wild river cannot be explained by a linear combination of factors (TN 27.) From a practical point of view, park design models which only specify the relative importance of variables, and then just sum or multiply, are quantitatively and conceptually unsound. As indicated in TN 27, people usually consider several resources at one time. The available "computer attractiveness evaluation packages" do not allow for multiple-consideration of resource variables. Furthermore, even if computer programmes included such an approach, there is still need for a valid, empirically based model. Effective use of computers to generate maps of peoples' reactions to resources requires extremely sophicated research work - work which has not been done at this time.

Thus, when it comes to examining the more general questions concerning attractiveness, such as how people respond to trails, or lakes, or scenic byways, and the like (see TN 22), has obvious research implications. Such

complexities as a response at a given time with respect to a given experience, or how the repetition of the experience may diminish the value of individual site qualities, creating a different response at different times; or how a variety of experiences may enhance total experience and thus alter response, are all research questions to be pursued.

SUPPLY ANALYSIS

The use of multiple regression to calculate "consumption" of recreation which is conditioned by socio-economic characteristics is illustrated in TN 12. TN 6 demonstrates how the TN 12 calculation formula for making estimates is of such form, that accuracy of estimates can be derived. The merits of using the TN 12 methodology to make predictions must be viewed in light of the accuracy considerations offered in TN 6.

However, in this volume, it is also pointed out that the conceptual structural problems indicated in TN 13, and the model structural problems pursued in TN 20 must be recognized.

TN 20 indicates that the variance in participation data is not adequately explained by use of the TN 12 model. TN 20 was designed to determine interaction effects which could be introduced to improve the TN 12 model. It was demonstrated that some significant effects could be incorporated into ANOVA models. However, when an AID analysis was compared to an ANOVA analysis, it was found that an ANOVA model only explained about half of the variance it should have. Thus including interaction effects does not improve simple ANOVA models. The preceding means that accuracy estimation methods used in TN 6, can be used for models, but when interaction terms or supply factors are not properly considered or are not included in models, TN 6 formulae (at best) seriously underestimates the error to be expected.

A number of considerations are important in defining the quantity of supply. Supply measurement is discussed in TN 16, where the measurement of how much supply is actually at each of a number of locations, and not with perceived supply. It must be recognized that the manner in which supply measurements are taken in one political jurisdiction may not be germane in another political jurisdiction. In addition, the real supply may not have a simple direct effect on use levels. It was pointed out in TN 29 as well as TN 34 that there have been studies in which researchers specified supply factors, and introduced these as additional independent variables when deriving an origin model. However, it has long been recognized that response to supply is non-linear (see TN 11).

One important innovation nevertheless, presented in TN 29, was that the effects of supply in each of the origin areas could be defined by what people do is in these areas (TN 29). The problem however, in determining how inventoried supply relates to the behaviourally based supply

coefficients. There is a need to consider programming of facilties, cultural factors, and other factors to relate model parameters to real supply and how it is used. Deriving an equation relating real supply to perceived supply is not a straightforward matter (see TN 10 and 37). To do this there is a need to conduct supply research using very large data sets for model development.

METHODOLOGICAL CONSIDERATIONS

Methodological considerations not covered elsewhere under other headings are discussed in this section. To provide an illustration of how an anlaysis of variance (ANOVA) model can be used, TN 15 was prepared. It was though that some readers might find the example helpful in examining the use of ANOVA model parameters in a number of the Technical Notes. Another area of methodological concern was data weighting. The procedures necessary to define appropriate weights for data collection involve a number of issues. TN 21 explores many of these issues; however, there is considerable room for development of new and more innovative weighting strategies. The material presented in TN 21 should not be considered optimal.

The processing of geographical information was yet another major area of methodological consideration. Many people frequently misuse computer systems in handling geographic information. There are numerous alternative methods of processing geographical information. However, often vast amounts of information are coded without regard to the ultimate research objective. Another major factor often ignored in computerized geographic data processing relates to the actual cost of manipulating information. In addition, there is a tendency, because of the range of computer assistance available today, for a number of researchers to code and process much more data than is actually necessary - just because the computer resources are available. Indeed this is a poor use of resources.

The issue of data compatibility is discussed in TN 24. It was learned that certain data which should be compatible with other data, was not. This issue should have been pursued more fully in the CORD Study. The Note raises serious questions about the validity and reliability of data.

In a fairly unbiased manner, TN 10 explores a rather interesting methodological consideration. Using the same data concerning participation in outdoor recreation activities, researchers conducted an R-mode Factor Analysis of the data, and a Cluster Analysis. Unfortunately, results of these two techniques should not be (but often are) compared. "R" Factor Analysis groups activities, and Cluster Analysis groups like individuals. A Q-mode Factor Analysis could have been used for this comparison, but wasn't, since the point was to demonstrate why R-mode Factor Analysis and Cluster Analysis differ. Similar methodolgical concerns are

examined in TN 13, 32, and 37.

Thus, The CORD Study has explored a number of methdological considerations which are not only of concern to outdoor recreation research, but are germane to all social and behavioural research. Findings indicate that it is important that similar methodological research be continued and considerable information exchange be encouraged. This latter point is particularly true with respect to the many fields of study which have the same methodological concerns.

ALLOCATION MODELLING AND ALLOCATION EVALUATION

Prior to 1974, there was little available information on the economic value of park visits. There is need for researchers to develop this kind of information in a form acceptable to many economists, and also in a form that is meaningful for policy makers. TN 31 makes a unique and potentially controversial contribution by implying that a systems model (such as the one defined in TN 1) can be used to define a demand function for non-isolated sites. This is the type of research required so that economists and policy makers might have some understanding of the economic effect of changing a system, i.e. - what happens to demand under new supply conditions.

Another issue considered in TN 31 is the estimation of per capita consumer surplus value. However, a special "easy, fast, and cheap" means, is also described in TN 38. Many may argue that this approach in TN 38 is not defensible. Special attention should be paid to the listing of consumer surplus values presented in the Appendix to TN 38, since this listing is the most extensive and diverse listing for Canada which is now available.

The concept of potential surfaces (both a sociologic and geographic concept) may be used to define measures for evaluating the distribution of opportunities to participate in outdoor recreation activities. Two approaches to measurement with respect to this concept are presented in TN 5, and in some respects, one can be said to be better than the other. The question of what distance function to use when certain gravity functions are specified remains unanswered. An interesting subsequent project would involve relating potential measures to some statement about perceived supply or to compare views about needs derived by the "Potential Surface" method with people's perception of their needs.

TN 17 offers an excellent example of the kind of issues alluded to in the comments on TN 5. If the policy decision is to provide opportunities for all people to have about the same per capita access to picnic sites within two hours drive of their homes, then there is no need to know how people behave, but rather there is need to have an inventory of the available opportunities for picnics. Such opportunities must be related to the population that will

use them and to the distance from opportunities, to the users. TN 17 provides a way of testing the goodness of any allocation. If certain access criteria are accepted, then TN 7 indicates how allocation evaluation measures can be defined by supply information. With the information produced from an "evaluation run" and information on expected population growth, facility development plans may be proposed based upon a knowledge of the "consequences" of changes in supply. This is accomplished by repeated "runs" of the model. Thus the model may be used to develop a "capital plan" for increasing supply - a plan that is consistent with budget forecasts over a period of time.

Concerns about the optimal use of land are examined in TN 23. One approach to defining optimal use is linear programming. However, the question is never really "should there be a park or timber production" - creation of parks rarely has a simple or single objective. For example, if the concern is employment, the computer might still select a capital-intensive solution. A solution to the land allocation problem might in fact take agricultural land out of production when it might be more valuable at a later time for agriculture. Current automatic evaluation and allocation procedures fail to take into account the multi-facted aspects of determining what may be "optimal" in a given socio-political situation.

Another issue concerning allocation models deals with behavioural data. TN 26 offers a method for using behavioural data in a disaggregated manner. For example, examining different age groups, or differences between males and females - rather than looking at crude participation rates for a "population". However, if a policy maker doesn't plan to make use of such information in planning or management action, such analyses are meaningless as the Note stresses.

In addition, sometimes data used for policy decisions are not quantitative. TN 25 indicates that it is possible to use intuition and judgement to scale qualitative data. The Note indicates that both quantitative and qualitative data should be used, however, controls should be built-in to prevent qualitative variables from dominating, and thus, making PPBS or similar management systems meaningless.

A focused review of traditional economic impact literature appears in TN 39. The Note leaves much to be desired because the literature is so extensive, and the issues are quite subtle. The Note should be considered as introductory to "the state of the art" as of the late 1960's. In contrast, TN 40 offers a perspective on what influences the development of a park. The Note points out problems of taking into account that developments almost never proceed according to a proposed "master plan", particularly with respect to park acquisition negotiations. The question of impact assessment requires examination of a variety of exogeneous and indogeneous variables. Finally, in the matter of the success of campgrounds, TN 41 must be considered a "first" guide for program managers and

planners. The economics of campground development must always be viewed within the context of the objectives of the proposed management.

Thus, it becomes obvious in this section that further research in the area of allocation modelling and allocation evaluation is extremely necessary.

QUO VADIS ?

If any conclusion can be drawn from the myriad avenues of research that have been reported in this volume, it is that future research to improve models must not be pursued in a random or haphazard manner. Researchers must not accept only the priorities of policy and planning personnel, but must establish their own priorities. Some work must be done ahead if results are to be produced at the time when requests may be expected. Furthermore, policy and planning personnel must understand that marginally relevant research can sometimes pay high dividends, and thus must permit researchers the time, and the latitude to pursue the more esoteric lines of inquiry opened by the CORD Study.

While many readers of this volume may feel that some of the material presented is quite relevant to their concerns, they do not understand how to use or adopt the methods presented to meet their needs. Interpretative material on how to use various methods developed by the CORD Study needs to be issued for practitioners. Practitioners have need of methodological guidelines and examplar materials. Manuals for carrying out research and for deriving the implication of research findings for management must be conceptualized as "useable tools", if they are to be anything other than academic exercises. There are a limited number of researchers who have the background required to make use of the material presented in this volume in its present form. In fact, there is a limited number of source persons who have drawn together the various contents of the Technical Notes. Still, this volume now may serve as text to increase the knowledge base of future outdoor recreation researchers.

APPENDIX A

REGRESSION ANALYSIS WITH DICHOTOMOUS DEPENDENT VARIABLES

V.K. Smith and C. Cicchetti

INTRODUCTION

An increasing volume of social science survey research has required the use of dichotomous dependent variables to estimate linear probability models. Linear probability functions may also be estimated from aggregate time series data where the dependent variables are not dichotomous (see Reference 10). As a consequence there has been considerable interest generated in the interpretation and the properties of statistics estimated with these models (see Reference 12, 13, 18). Those texts which discuss estimators for such models (see Reference 7, 8, 17) present three types of estimation procedures. The first category includes the probit-like techniques (e.g., probit, logit, tobit). While there is general agreement, on theoretical grounds, that these techniques are most desirable, they are infrequently used in practice. Cost considerations have been cited as a primary reason. A number of researchers (see Reference 2, 6) have pointed to the computational costs of these methods with large data sets as primary obstacles to their application. In the context of the CORD Study, cost and other considerations are commented on in several Notes as well as in the review of Chapter VII. The second approach requires the use of a mathematical programming technique. It is derived by selecting parameter estimates so as to minimize the sum of squared residuals subject to inequality constraints upon the model's predictions. Judge and Takayma (see Reference 9) have noted that minimization of the sum of squared residuals subject to $0 \leq X(i) \leq 1$ becomes a quadratic programming problem where the covariance matrix of coefficient estimates is not clear. Once again these techniques have not been employed in many applications (e.g. see Reference 10). One reason stems from a general inability to derive a covariance matrix for the estimated coefficients (see Reference 9).

The other set of techniques involves applying ordinary least squares (OLS) and generalized least squares (GLS) procedures directly to the data. These estimators (OLS and GLS) have been used in the majority of applied studies with dichotomous dependent variables. While their asymptotic properties are known, it is probably fair to say that there has been no evaluation of their sampling performance. Moreover, there is very little information available to discriminate between OLS and GLS procedures.

The purpose of this paper is to present the results of a series of Monte Carlo experiments with models containing

dichotomous dependent variables. This study is concerned only with OLS and GLS estimators. The evaluation of their performance involves consideration of both estimated coefficients and their estimated covariance matrix. In addition the power of Student t-tests is discussed.

There are several reasons for the restriction in scope of the paper. However, the primary reason stems from the desire to evaluate methods which are used in practice for research with dichotomous variables and thereby serve to improve the process of selection between them. Moreover, the popularity of these techniques without explicit knowledge of their small sample properties (see Reference 13) reinforces this consideration. The recent work by Cragg examines some of these issues (see Reference 4).

MODEL

Goldberger provides a clearcut statement of the dichotomous dependent variable linear probability model in his text. Equation 1 is a statement of a linear probability function of the kind of concern here. The values of Y(i) are restricted to zero or unity. β is a K by 1 parameter vector. X is a 1 by K vector of exogenous variables X(i) and U is the error vector with elements U(i).

(1) $$Y = X\beta + U$$

In order to satisfy one assumption of the general linear model, E(U(i)) = 0, Goldberger derived a prerequisite distribution for U(i). He indicated that U(i) be a Bernoulli random variable for which the distribution is:

(2)

U(i)'s VALUE	PROBABILITY OF THAT VALUE
$1-X(i)B$	$X(i)\beta$
$-X(i)B$	$1-X(i)\beta$

This specification implies that U is heteroscedastic. Accordingly, Aitken estimation of the model has been suggested. The variance of U(i) is given in Equation 3:

(3) $$E(U(i)^2) = X(i)B\,(1-X(i)\beta) = E(Y(i))\,(1-E(Y(i)))$$

McGillivray (see Reference 11) has recently demonstrated that EVAR(i)= y(i)(1-y(i)), where y(i) is the OLS prediction, provides a consistent estimator of E(Y(i)) (1-E(Y(i))). Moreover the Aitken estimates which result are best asymptotically normal (BAN). This estimate of the disturbance covariance matrix required for GLS estimation used y(i)(1-y(i)) as the diagonal elements. There is, however, a significant problem with this procedure, as Goldberger has noted: "...there may be x(i)'s for which y(i) is outside the unit interval." In such cases, the estimates

of the variance EVAR(i) are inadmissible and there is no clearly defined procedure for the application of the GLS technique.

Accordingly, three schemes for dealing with sample points which result in such inadmissible estimates are examined. Figure 1 shows a plot of the weighting scheme EVAR(i) for sample points for which predictions of their Y(i) lie within the unit interval. The primary question of concern here however is what weight to assign to observations for which y(i)'s are outside the interval. One weighting technique gives outliers a weight, which corresponds to the smallest weight given to the observations within the 0 to 1 interval (this weight corresponds to the weight given to y(i) = .5). This estimator is designated GLS1. This weighting function corresponds to line segments AB and CD in Figure 1 and implies a weight of 1/4 for those observations for which y(i) falls outside the unit interval. This scheme implies that the information embodied in these observations is small. Alternatively, outliers (see Reference 5) may be weighted in a manner (GLS2) which reduces the information content of the observations as a function of the extent to which the estimated y(i) is outside the 0 to 1 interval. One method which accomplishes this is indicated by the weight curves EF and GH in Figure 1. These curves are 1 divided by the absolute value of y(i)*(1-y(i)). Finally, observations outside the unit interval might be given larger weights in order to improve the likelihood that the (Aitken) estimated probability function will not predict with sample points outside the 0 to 1 interval. As representative of such cases a weight was chosen corresponding to y(i)=.98, whenever y(i) was actually less than zero or greater than one, and designated GLS3 weights. In Figure 1, the weighting function corresponding to GLS3 is shown by IJ and KL.

In summary, the three weighting functions and their corresponding generalized least squares estimators are presented in Table 1.

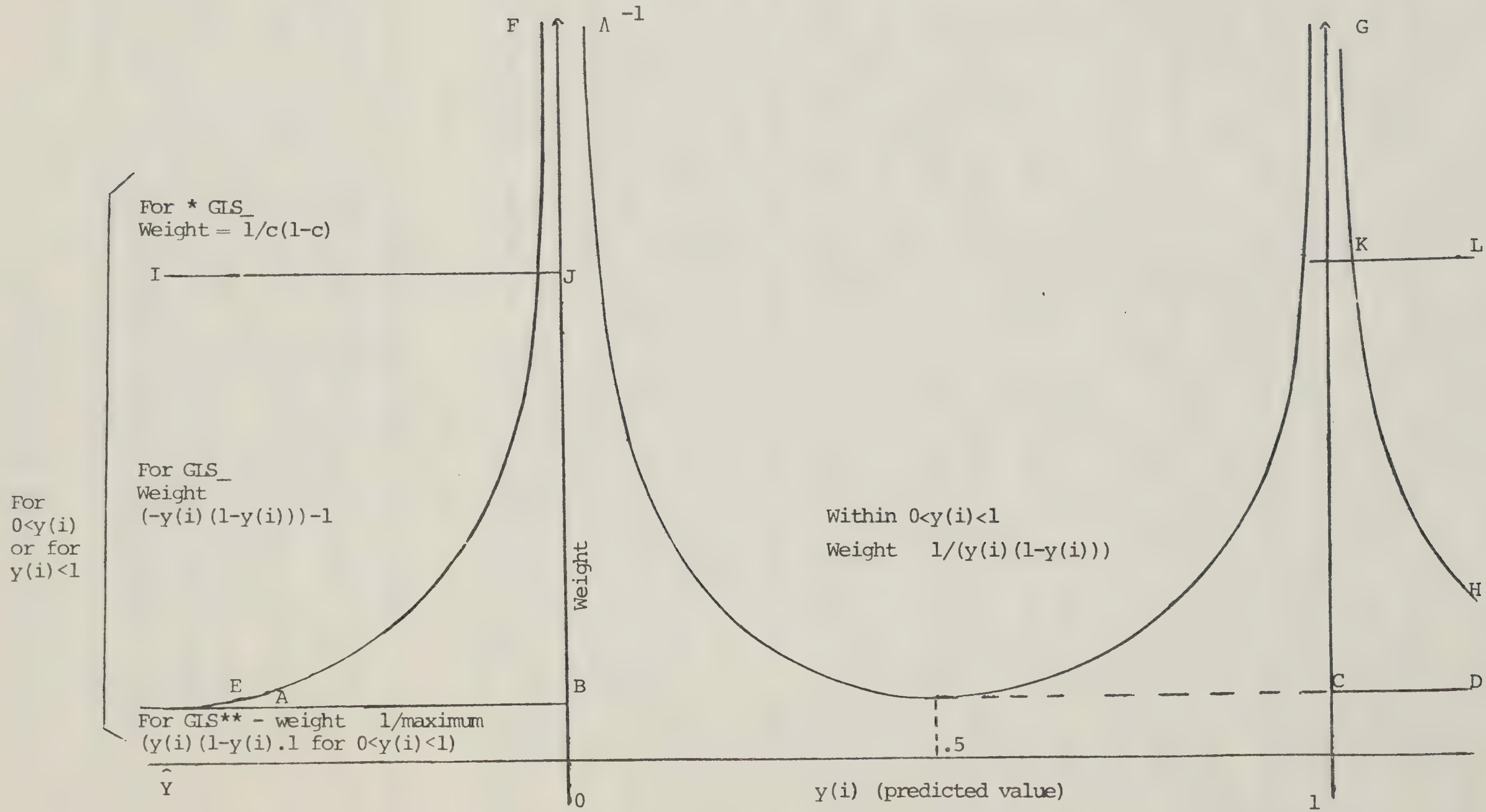
DESIGN OF THE EXPERIMENTS

A total of twelve experiments each with fifty samples have been conducted to compare the performances of OLS and the three GLS estimators described above. There are three factors which distinguish these experiments: model, conditional distributions of U(i), and sample size. Three conditional distributions for U(i) are used with two different models. Each experiment is conducted with samples containing twelve and one hundred observations. The general form of the model used to generate samples is defined by Equation 5:

(5) Y(i) = B(0) + B(1)X(1,i) + B(2)X(2,i) + U(i)

The two models have different specifications for the

Figure 1 Weights to be Used in Making Different GLS Estimates of the Parameter of a Model with a Dichotomous Dependent Variable



* the constant c as indicated in the paper may be .01 or any small constant

** This has a minimum value of 4 which the value indicated in the figure

TABLE 1: ALTERNATIVE GLS ESTIMATORS FUNCTIONS AS GIVEN IN FIGURE 1

Estimator	For y(i)LT 0	For 0 LT y(i)LT 1	For y(i)GT 1
GLS1	AB	1/EVAR(i)	CD
GLS2	EF	1/EVAR(i)	GH
GLS3	IJ	1/EVAR(i)	KL

TABLE 2: SUMMARY OF EXPERIMENT'S COEFFICIENT STRUCTURES

Model and Experiment	B(o)	B(1)	B(2)	Approx.[1] Proportions of Y's Equal to 1	Max P(Y=1)
A 1	.25	.25	-.05	.30	.48
A 2	.45	.25	-.05	.50	.68
A 3	.65	.25	-.05	.70	.88
B 1	.16	.25	-.05	.30	.41
B 2	.36	.25	-.05	.50	.61
B 3	.56	.25	-.05	.70	.81

1. This estimate is derived recognizing that the probability Y(i) is equal to one is equal to Σ B(j) x(j,i) where the sum is for j=zero to two. Substituting the mean values for independent variables one obtains the approximate proportion as reported above.

regressors, X(1,i) and X(2,i). In Model A there is a dichotomous independent variable, X(1,i), and a continuous independent variable X(2,i). In Model B both independent variables are dichotomous. The values of the independent variables (for each sample size) were not changed across or within the different experiments for each model.

They were obtained by generating twenty random numbers for each variable in the case of samples of size twenty and one hundred for the larger samples. The variable X(1,i) came from a discrete distribution and had values of zero and unity with P(X(1,i)=1)=.5. For model A, X(2,i) came from a normal population, N(2,1.0). For model B, X(2,i) was discreet with values of zero and unity, with P(X(2,i)=1)=.2. The variables for both models were independently generated. In Table 2, the coefficient structures used for each experiment are presented, and the effect upon the distribution of the dependent variable Y(i), is also "described" in each case.

The distribution U(i) was altered by changing the intercept of the equations for each model. This change, with the same values for the independent variables, respecifies both the magnitude of the errors and their probability distributions.

PERFORMANCE OF THE ESTIMATORS IN OBTAINING COEFFICIENT ESTIMATES

Two types of measures of performance for OLS, GLS1, GLS2 and GLS3 estimators are reported for each model. They are parametric and non-parametric statistics. In the actual analysis, results were produced for each coefficient in each experiment for both models. Sample mean, root mean square error (RMSE), bias, and variance for coefficients were developed and examined for each coefficient experiment-model combination. A number of patterns were apparent. Using Model A with sample sizes of 20, in terms of RMSE and variance explained, GLS3 appears to be better than OLS and the other GLS techniques. In Model B, with samples of 20, OLS comes somewhat closer to the GLS estimators using these same criteria.

Increasing sample size to 100 observations was seen to have three effects. (1) Each technique's performance under all four criteria improves as would be expected with increased sample size. Moreover, the parametric statistics (e.g., bias, RMSE and variance) for each estimator are, with but few exceptions, one-half their former levels. (2) The perceived discrepancy between the performance of the three GLS techniques is virtually eliminated. Thus the procedure used to accommodate inadmissible variance estimates does not appear important with larger samples. (3) Finally, the observed discrepancy between the GLS techniques and OLS with samples of twenty (20) observations is practically eliminated when the sample size is increased to one hundred (100) observations.

Another aspect of the results that were considered concerns decentralization. Quandi (see Reference 14) introduced the decentralization measure when the primary concern was for the frequency of extreme errors. It is given by the percent of samples within which the estimated coefficients had the wrong sign (relative to the total number of samples). Table 3 presents this percentage for the OLS and GLS estimators. There is no difference in decentralization between GLS1, GLS2 and GLS3, therefore, the decentralization for these estimators is reported in Table 3 under the general heading GLS. In nearly all cases, increased sample size greatly reduces or eliminates the decentralization that is present in samples of twenty observations. Furthermore, the pattern does not appear to differ appreciably across the two estimating techniques.

Also in Table 3 there is a Kendall's coefficient of concordance for each structural coefficient across all experiments. This nonparametric statistic measures the agreement in ranking (according to absolute proximity to the true value) of OLS and each GLS estimator across the fifty samples of each experiment. This measure is calculated by comparing each estimator's rank sum with what it would have been if there was perfect agreement. Accordingly, the coefficient may be loosely interpreted as the percent of perfect agreement in these rankings.

Overall the estimator rankings are not highly consistent in either model for any of the GLS techniques. It appears that the consistency in the ranking declines with increases in sample size. While there are some exceptions, this conclusion reinforces the results found for the parametric statistics. That is, the techniques do not exhibit appreciable difference in performance patterns with larger samples.

ESTIMATES OF THE COEFFICIENT VARIANCES

An additional aspect of the performance of each estimating technique is its estimate of the estimated coefficients, covariance matrix. The calculation of these variance-covariance matrices is carried out using the standard formula referred to later. The OLS estimates of the variance-covariance matrix for the estimated coefficients are known to be biased in the presence of heteroscedastic disturbances (see References 1, 7, 8, 17). Still GLS, in principle, should provide asymptotically unbiased estimates. Table 4 presents the mean of the fifty estimates of the estimated coefficients, variances for models A and B. In addition the mean squared errors (MSE) of the individual coefficient's estimates are presented for comparison. The difference should provide some indication of the extent of the bias in the respective estimators.

Some overall observations are possible. (1) OLS and all GLS estimates of the variance in the estimated coefficients are biased. The magnitude of the bias

TABLE 3 SOME NON PARAMETRIC TEST RESULTS

			Kendall's Coefficient of Concordance (Consistency in Estimator Ranking									Structural Decentralization in Percent					
			GLS1			GLS2			GLS3			OLS			GLS		
Model	Experiment	Sample Size	B(0)	B(1)	B(2)	B(0)	B(1)	B(2)	B(0)	B(1)	B(2)	B(0)	B(1)	B(2)	B(0)	B(1)	B(2)
A	1	20	.2304	.0256	.0784	.0144	.0256	.0064	.0000	.0000	.0016	22	10	34	24	12	34
		100	.0016	.0064	.0144	.0000	.0000	.0256	.0016	.0000	.0144	2	2	12	00	2	10
A	2	20	.0256	.0144	.0784	.0256	.0400	.0400	.0016	.0376	.0064	12	14	34	8	16	36
		100	.0144	.0144	.0784	.0144	.0064	.0576	.0144	.0064	.0576	00	00	4	00	00	6
A	3	20	.0000	.0016	.0144	.0400	.0000	.0400	.0576	.0016	.1024	2	12	30	2	12	32
		100	.0064	.0144	.0064	.0144	.0144	.0064	.0064	.0144	.0064	00	00	18	00	00	16
B	1	20	.2704	.0016	.1024	.0576	.0144	.0400	.0064	.0064	.7056	8	4	28	8	4	48
		100	.0576	.0256	.0256	.0576	.0016	.0400	.0400	.0000	.0400	00	00	34	00	00	38
B	2	20	.0144	.0144	.0024	.0064	é0064	.0256	.0064	.0000	.2704	00	12	46	00	12	38
		100	.0000	.0016	.0400	.0000	.0016	.0400	.0000	.0016	.0400	00	00	28	00	00	28
B	3	20	.0000	.0144	.1296	.0256	.0064	.0064	.0016	.1936	.5184	00	8	32	00	8	32
		100	.0000	.0016	.1024	.0000	.0016	.1024	.0000	.0016	.1024	00	00	42	00	00	36

Table 4: Sample Variance Estimates for the Estimated Coefficients: Model A and B

			OLS		GLS1		GLS2		GLS3	
Exp.	Coefficient	Sample Size	Mean	MSE	Mean	MSE	Mean	MSE	Mean	MSE
A2	B(0)	20	.0911	.1025	.0725	.1137	.0705	.1017	.0695	.0958
		100	.0185	.0158	.0180	.0154	.0180	.0162	.0180	.0163
	B(1)	20	.0518	.0475	.0425	.0484	.0419	.0459	.0418	.0455
		100	.0094	.0104	.0092	.0105	.0092	.0103	.0092	.0103
	B(2)	20	.0119	.0130	.0093	.0153	.0090	.0142	.0089	.0133
		100	.0026	.0013	.0024	.0014	.0024	.0014	.0024	.0014
B2	B(0)	20	.0021	.0183	.0195	.0185	.0191	.0188	.0187	.0184
		100	.0055	.0085	.0051	.0087	.0051	.0087	.0051	.0087
	B(1)	20	.0468	.0578	.0413	.0583	.0393	.0588	.0373	.0558
		100	.0095	.0108	.0090	.0108	.0090	.0108	.0090	.0108
	B(2)	20	.1287	.0864	.1026	.1009	.0979	.0955	.0797	.0610
		100	.0174	.0162	.0157	.0160	.0157	.0160	.0157	.0160

Table 5: STUDENT'S T-TEST PERFORMANCE
Percent of Samples for which the Null Hypothesis were rejected

Model and Experiment	Sample Size	OLS	Range in GLS1-3	GLS2	GLS3
A1	20	22	32	30	30
	100	72	78	76	78
2	20	18	22	22	20
	100	74	76	76	76
3	20	26	22	20	20
	100	70	70	70	70
B1	20	28	24	26	26
	100	80	84	84	84
2	20	26	26	26	26
	100	66	64	64	64
3	20	44	44	44	44
	100	66	64	64	64

diminishes with increased sample size. (2) The distinction between the three GLS estimators of the variance virtually disappears when the sample is increased to a size of one hundred.

As a final step we consider the suitability of Student's t-tests for hypothesis-testing with linear probability models for the dichotomous dependent variables studied here. Table 5 shows the percent of the sample in which the null hypothesis (coefficients equal zero) was rejected at the .05 level. These results indicate that the power of this test is quite limited for small samples (20 or less). Furthermore, there does not appear to be any difference in the performance of the four estimators, which were considered. However, with increased sample size (100) the t-test becomes a much more powerful test and it becomes appropriate to test hypotheses with the estimated coefficients.

CONCLUSIONS

These experiments provide a number of interesting findings. First, under small sample conditions, a GLS estimator, which gives a large weight to observations outside the 0 to 1 interval seems to be marginally better than OLS when the regressors include a continuous variable. However, this ranking is weakened if the regressors are both dichotomous variables. Moreover, when the sample size is increased (to one hundred observations) there are no apparent gains from Aitken (GLS) estimation. The results based upon both parametric and nonparametric statistics for the estimated coefficients reinforce this finding.

Second, both the OLS and GLS estimates of the estimated coefficients, variances are biased. While the magnitude of this bias diminishes with increased sample size, there is no apparent difference across estimators.

Third, the power of the Student's t-test for testing hypotheses with the estimated coefficients is very limited with small samples irrespective of the estimator selected. An increase in the sample size results in a more acceptable performance for this test. However, there is still no discernible advantage gained by using Aitken (GLS) estimation with larger samples.

Probably of most practical importance is that much survey research using dichotomous dependent variables for the estimation of linear probability functions utilizes fairly large data sets (in excess of one hundred observations) for statistical estimation. As a consequence, "probit-like" estimators impose substantial computational costs. Therefore, OLS or GLS procedures are frequently chosen. While our results cannot discern the loss in efficiency if an OLS estimator is utilized, they do indicate that there is little or no gain from using Aitken estimation for such large data sets. Moreover, traditional hypothesis testing with the Student's t-test for the coefficients of

such models can probably be expected to yield reasonably powerful tests with large samples.

A note of caution in closing. It must be emphasized that the above conclusions are based upon experimental models which assume that specification errors are not present in the model. Further research should address models of this kind when specification errors are present (see TN 6, 20, 29, and 36).

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APPENDIX B

CORD TECHNICAL NOTES
PREVIOUS PUBLICATION[1]

TN	AUTHOR	CITATION
1	Cheung	"A Day-Use Visitation Model", JOURNAL OF LEISURE RESEARCH, 4(2):1972:139-156.
4	Cesario	"A Simulation Approach to Outdoor Recreation Planning", JOURNAL OF LEISURE RESEARCH, 7(1):1975:38-52.
10	Romsa	"A Method of Deriving Outdoor Recreation Activity Packages", JOURNAL OF LEISURE RESEARCH, 5(4):1973:34-46.
13	Beaman	"Statistical Projections that Go Beyond Projections in Past Trends", GEOGRAPHICAL INTER-UNIVERSITY RESOURCE MANAGEMENT SEMINARS, 4:1973-1974.
14	Beaman	"Distance and the 'Reaction' to Distance as a Function of Distance", JOURNAL OF LEISURE RESEARCH, 6(3):1974:220-231.
16	Cox	"A Method for Calculating the Supply of Outdoor Recreation", Ontario Research Council on Leisure - RECREATION REVIEW, 2:August, 1972.
17	Acar	"A Method of Allocating Recreation Supply to Urban Centres", CANADIAN JOURNAL OF OPERATIONAL RESEARCH AND INFORMATION PROCESS (INFOR), 12(3):October, 1974.
23	Cheung & Auger	"Linear Programming and Land Use Allocation Suboptimal Solutions and Policy", SOCIO-ECONOMIC PLANNING JOURNAL, 1976.

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1. Some of the Technical Notes which appear in this volume have been published previously in a number of professional and scholarly journals. Certain previously published Notes have been completely revised for this publication, while others have been only modified slightly.

25	Acar	"An Integrated Approach to Multidimensional Evaluation and Cost-effectiveness Analysis", PUBLIC FINANCE /FINANCES PUBLIQUES, 31(1):1976:58-72.
32	Beaman & Lindsay	"Practical Applications of Cluster Analysis", Ontario Research Council on Leisure - RECREATION REVIEW, 4(3):1975:13-21.
37	Beaman	"Comments on the Paper 'The Substitutability Concept: Implications for Recreation Research and Management', by Hendee and Burdge", JOURNAL OF LEISURE RESEARCH, 7(2):1975;146-152.

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